Access to the River: Rethinking the Role of Storrow Drive

An Opportunity For Transportation Planning With Urban Objectives

by

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Submitted to the Department of Urban Studies and Planning
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE
in Transportation

at the
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

May 1992

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Abstract

Highway construction and expansion in the postwar years have created dramatic and damaging incisions into the urban park system. The consumption of valuable land by massive interchanges and curtailment of pedestrian mobility in and around these areas have had an especially severe impact along the Charles River Esplanade and its linkage points with the rest of the park system.

At a time where the final projects from the Boston Transportation Planning Review era are nearing completion, large increases in automobile travel are projected which will overload an already congested road network. As a response to these expected developments and the need to find alternative solutions to assure both mobility and Boston's urban vitality in the future, a new approach to transportation planning is proposed. Rather than simply continuing to accommodate growth in vehicular travel and mitigating its environmental consequences, an urban/environmental objective is formulated first and transportation policies devised such as to best manage transportation resources under the stated objective.

The application of this concept to Storrow Drive shows that accessibility from the abutting neighborhoods to the Esplanade and open space linkages could be substantially improved. While supporting policies could complement the endeavor to enhance the quality of the urban environment, the improvement of the urban environment would at the same time promote the application of these policies in order to achieve similar objectives elsewhere.

Environmental objectives will not only be aided by a policy approach which emphasizes the role of pedestrians and open space in cities but actually provide the impetus for an implementation of such measures. Therefore, rethinking the role of Storrow Drive could help to change the direction of urban transportation planning if it is understood as an exemplary effort by the community to reclaim urban spaces.

Preface

This project has been motivated to a large degree by a class taught by Dennis Frenchman, "Cities of Tomorrow." To think about how to plan tomorrow's cities we needed to understand what we liked and disliked about today's. It struck me that people seemed to dream of having the best of two world's by moving into more rural settings in the suburbs while maintaining a life line to the city. As the motor vehicle allowed more and more people to move out of the crowded inner cities, this concept began failing. To enjoy the natural environment now required substantial travel and the suburbs developing at the fringes of the growing metropolis began to lose both, the connection to the country *and* the connection to the city.

The desire to be both removed and connected to the "action" in cities has been a major force contributing to the suburban flight. The cost to inner city neighborhoods through highway construction has been substantial. Was this the price of realizing the dream of a house in the green and a job in the bustling city?

The suburban flight and its impact on inner cities is *not* the topic of this paper. However, my belief, that as residents or planners in cities we will always have to work to bring the "other," greener world closer, will repeatedly shine through. The expansion of open spaces in the city and improved mobility for pedestrians are important steps in this direction. Constraints imposed on the urban resident through the density and level of activity in city neighborhoods will need to be offset by a provision of assets where everyone can feel free to move, talk and repose in order to maintain the vitality which draws so many people to cities like Boston. This paper, although it moves across the board with urban design, transportation and policy analysis, recognizes this need as a central theme for planning.

I have a million people to thank for their time and support. First and foremost, I want to thank my thesis supervisor, Fred Salvucci, whose thoughtful comments always inspired my work. He has added much to my understanding of the relationship between good ideas and good policies. Many thanks to Ralph Gakenheimer who kindly offered to be a second reader early in the process. Dave Bernstein has been of incredible support during times when I started to go through the hardware blues. Tom Lisco and Eduardo Pereira at the Central Transportation Planning Staff have been of invaluable help in getting the data and spending the time with me to understand what they really mean. I have spent many hours at CTPS and the discussions with Tom and Eduardo have yielded me some valuable insights into the transportation modeling process. I also want to thank their colleagues Karl Quackenbush, Matt Plager, Jeff Slater, Sonia Hamel, Ien Harrington, Jim Gallagher and all the others who had to put up with my constant data requests and queries over the phone or in person. Without all their help, the transportation analysis in this paper would not have been possible.

Malcolm Davis, Antonio DiMambro, Ed Nilsson and Roman Koebel have all given me constructive feedback on earlier and later drafts of this paper which have helped me to focus on some important issues. Doug Lee has been extremely supportive in helping me assemble the necessary software, and Bruce Campbell took the time to review my layman's work at early stages.

I want to thank the following people for taking the time for a brief interview during the last months: Jack Wofford, Ken Kruckemeyer, Bob O'Brien, Peter Roudebush, Jerome Rothenberg, Dick Garver, Karl Haglund, Julia O'Brien, Peter Thomson, Ed Nilsson, Anthony Pangaro, Joe Beggan, Marc Primack, Joe Aiello, Peter Calcaterra, John Maservi, Steve Kaiser, Liz Epstein, Matt Coogan, Alan Altshuler, Louise Lewis, Danny King, Marc Cutler, Thomas Rossi, Hugh Russell, and William Kuttner. Furthermore, some people have helped me to obtain data and given useful hints among which are Jane Howard, Basil Tommy, Mindy McNeill, Ken Small, Gary Hack, Simon Lewis and Peter Howe.

My roommate, Eric, has helped me through my C-programs during a time when he was going thesis-crazy himself. I want to especially thank Catherine Musinsky Dance Company. During the toughest weeks dancing has been a tough but important distraction from the perpetual academic striving. Finally, I want to thank Erika Kiss for her support during all the thesis time and especially for her expertise and hard work during the assembly of the final paper.

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INTRODUCTION

Facility of movement is one of the key determinants of economic growth in an urban area. A city will prosper if its workers and goods can be moved and information relayed efficiently between the locations of its activities. The endeavor to maximize access capacity to the employment core and between urban activity centers has consequently been a traditional centerpiece of transportation policies in metropolitan areas.

The manner in which people and goods movements are conducted in an urban area, however, greatly affects the environment in which they are realized. Community disruption, loss of valuable land, visual blight, noise, air pollution and infringement upon the safety of pedestrians and bicyclists are some of the most immediate impacts suffered by those residing near the corridors of such movements. While roadways are built to connect some, they will almost always separate others. Increasing accessibility for automobiles will often decrease accessibility for pedestrians. Transportation policy decisions must therefore not only ensure that certain transportation objectives are met, but also and especially be based upon environmental, social and urban design criteria.

Storrow Drive is a sad example of how an effort to pursue one objective, improving vehicle access within Boston's metropolitan area and therefore facilitating economic growth, effected the alienation of another, enhancing a park's visual and recreational function. The Charles River Esplanade abutting Storrow Drive is one of the most beautiful and memorable pieces of Boston's urban fabric. The river park provides recreation for thousands of residents and visitors and offers one of the most exciting views of Boston's cityscape as contrasted with the natural open space. While the scenic views enjoyed by drivers on Storrow Drive gives the Esplanade some of its value, the same roadway hampers the simple enjoyment and accessibility of the park by those who reside or walk in its proximity. Portraying the ambivalent role of Storrow Drive as a link, on the one hand, and a barrier, on the other, is the object of Part I of this thesis.

The impact of highways on the quality of the urban living experience calls for a changed role of urban transportation planning. Instead of merely providing for the accommodation of mobility demands associated with the functioning of the urban system, transportation planning here is proposed to play a pro-active role. Automobile trips are not treated as predetermined quantities but rather as functions of specific policy measures. This approach reverses the sequential hierarchy of the planning process traditionally applied. Whereas today we look for environmental design measures best mitigating the negative effects of a given planned transportation project, the intent here is to formulate the environmental/urban design improvement as the primary **policy goal** and then find measures which minimize its negative transportation impact. This approach has the advantage that it recognizes the health of the urban environment as the essence of any kind of planning in a city where people live and work. The revitalization of the park system, promotion of pedestrian circulation, improvement of urban links and expansion of the role of transit serve as the basis for formulating options regarding the many possible futures of Storrow Drive which are explored in Part II. Through the insertion of some specific detail on options at important nodes along Storrow Drive, the analysis seeks to focus the discussion by conceptualizing how these general ideas could be translated into specific actions in situ.

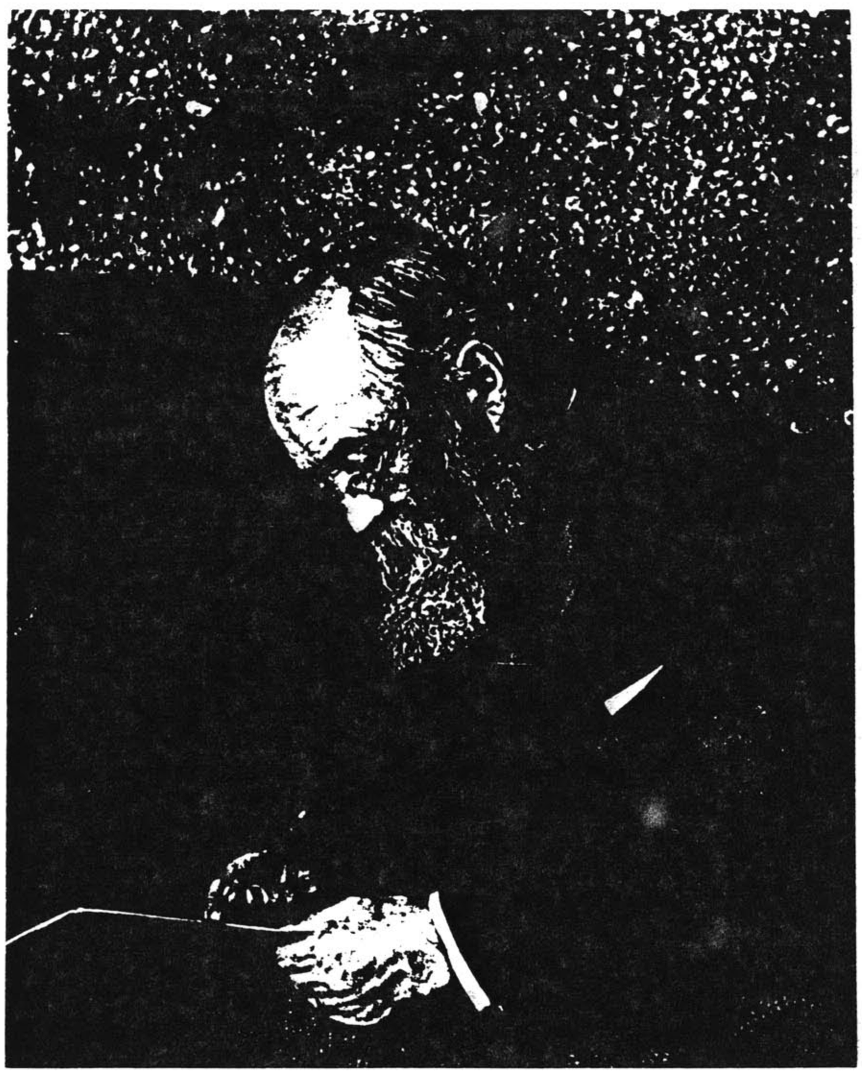
The realization of concepts explored in Part II depends on a variety of factors. One is the application of policies which would complement the objective pursued in downgrading Storrow Drive. A set of sensitivity analyses seeks to address the question of how the transportation impact of envisioned environmental improvements could be mitigated through the application of specific policies. A second is the compatibility of the envisioned environmental improvement with other objectives of residents, businesses and policy makers. An assessment of which positions are held by members of the affected parties serves as an initial measure of support for a downgrading of Storrow Drive. A third factor is the timeliness of the proposal. At a time where the largest public works project in the history of the Commonwealth, the Central Artery/Third Harbor Tunnel (CA/T) project, is nearing its inception, there is a unique opportunity to write a new chapter in Boston's urban transportation history. Designed to remove a central bottleneck and traffic from local and arterial streets in its vicinity, the CA/T project provides a timely occasion to think about how to best reap these benefits. Coinciding with this event is the passage of an innovative piece of national legislation, the Intermodal Surface Transportation Efficiency Act of 1991, which could further lead the way to massive improvements in public transportation and the pedestrian environment. A discussion of these linkages is the object of Part III.

Considering both the uniqueness of this coincidence and the continuing need to improve the quality of Boston's urban environment, the ideas put forth for Storrow Drive should serve as a basis to promote a vigorous and sincere participatory discussion about how these benefits could best be translated into local improvements for communities elsewhere.

As a result, this paper hopes to give a taste of Boston's potential to reclaim some of its "lost" urban space. It will generate a framework for the formulation of future transportation policy objectives by providing a sense of what policy makers can do and should do in this time of changing environmental priorities.

BACKGROUND
PARKS, PEOPLE, PROGRESS
AND THE ADVENT OF THE AUTOMOBILE

The Esplanade and Storrow Drive have four distinctive yet interwoven histories. First, the transformation of the former estuary and creation of the Back Bay is the foundation for the geographical topography of the Charles River Basin which has lasted until this day. Second, the park movement which evolved around the last quarter of the 19th century was one of the main forces behind creating and integrating the basin and



other contiguous land into an urban park system. Third, the development of the Esplanade is a direct consequence of these influences. If the damming of the river initially yielded the technical potential to develop the basin at all, it was the landscape architects, prominent visionaries and motivated citizens who were the ultimate leaders in creating the park environment which became reality. Finally, during the postwar period the river basin's environment was radically transformed to suit the needs of automobiles. The Storrow Drive Expressway itself and interchanges along its length are some of the traces this encroachment has left until today.

The Creation of the Charles River Basin

Less than two centuries ago, what today we call the Charles River Basin was a large estuary extending to Watertown twice a day and expanding and contracting with the tide of the sea (**Figure B-1**).[1] When Captain John Smith explored the waters in 1614, he named it after his patron, Prince Charles of England, because it was so wide in its lower part that he believed it was a grand river.[2] The bay was bounded by the Boston Common to the East, Washington Street to the South, Sewell's Point, now Kenmore Square, to the West and almost what is known today as Central Square to the North. In 1821, the Mill Dam was completed, connecting Boston Proper, which at that time extended to about Charles Street on the West, to Sewell's Point. This historic toll road is the Beacon Street of today. In addition to serving as a connector between formerly separated parts of the region, the dam was used to capture tidal power to run mills along its embankment.

The dam had a dramatic impact on the sensitive estuarine ecology in that it prevented tidal currents from cleaning out accumulating sewage released into the receiving basin by the growing city. In 1849, the Back Bay was regarded "nothing less than a cesspool" by the Boston City Council, an odoriferous dump posing a sanitary threat to the citizens during low tide.[3] In the following years, demands that the city or state ameliorate the situation grew, especially by those who couldn't afford to leave the city in the summer.[4]

Figure B-1. A Plan of Boston With Environs by Henry Pelham, 1777.

A compromise between the city, the state and the owners of the mill dam was reached in 1856 when the state gained ownership of the predominant portion of land to the south of the dam and the mill owners received development rights for one row of houses along the north side of the dam.[5] Years later, during the planning stages for construction of the Charles River Dam, proposals to add another row of town houses fronting on the basin were repeatedly opposed by the wealthy owners of North Beacon

Street residences as they would have blocked their view on the river. This is why the Back Bay until this day still backs, rather than faces the Charles River Basin.[6]

As a result of the agreement reached and backed by the need to accommodate a rapidly growing population, the muddy and shallow Back Bay receiving basin was filled between 1859 and 1877 between Charles Street on the East and the Fenway in the West.[7] Construction proceeded rapidly and the Back Bay in the layout we find today was completed almost simultaneously with the filling of the mudflats as is shown in **Figure B-2.** Quickly, the Back Bay became a fashionable place to live for wealthy Bostonians who moved out of their crowded residences in the 'old' city.[8,9] With the construction of the Charles River Dam in 1910, the Charles River completed its transformation from an open salt water estuary to a contained freshwater receptacle. The Charles River Basin was born.

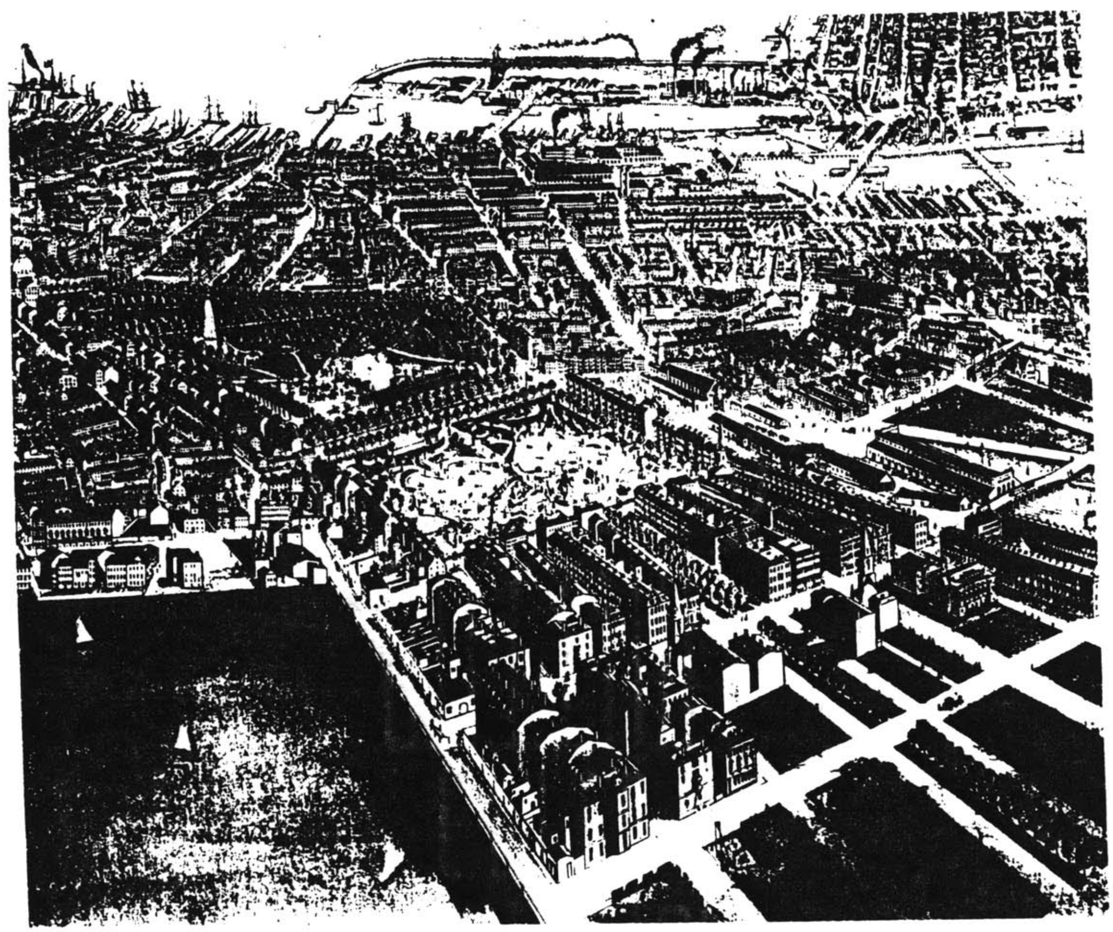


Figure B-2. Birds-Eye View of Boston and Back Bay by F. Fuchs (detail), 1870.

The Park Movement

The urban landscape of eastern metropolitan cities was radically transformed during the 19th century through massive urbanization and industrialization. These changes led to dramatically increased demands on sanitation, housing and traffic circulation.[10] As more and more land was devoured to construct infrastructure necessary to support these demands, spaces to escape congestion and pollution associated with the city were becoming increasingly scarce.

With the advent of public transportation, residences in more rural settings along the periphery of the city became increasingly popular. At the same time, land values in the urban core began rising sharply and private open space amenities in the central city vanished at an accelerating rate. Boston compared quite unfavorably with other cities, such as New York, Chicago and Philadelphia, in terms of acreage of public open space.[11] The need to have more open space available to the public, as well as the concurrent and growing desire to "return to closer harmony with nature" stimulated by writings of George B. Emerson and Henry D. Thoreau, promoted the formation of an urban park movement by the mid-1800s.[12]

As the Back Bay and other parts of the city grew, enthusiasm for new parks increased.[13] In November 1869, Boston had its first major public hearing on the parks issue. One of the guiding objectives was accessibility. Most favored a series of small parks in the vicinity of many of the common people and many argued, that the parks should serve those not wealthy enough to reach the more remote sites in the countryside.[14,15]

The Mayor of Boston appointed a Park Commission in 1875 which made its first report the following year, proposing a park system linking the Charles River, parts of the Back Bay, Parker Hill, South Bay, Savin Hill, City Point, East Boston, Chestnut Hill, Jamaica Pond, and West Roxbury. Soon after the release of the report a public meeting named "Parks for People" was held at Faneuil Hall. A year later, in 1877, a first appropriation of nearly $1,000,000 was made by the city council.

The following two decades saw the construction of what is known today as

Boston's 'Emerald Necklace', a park system designed by Frederick Law Olmsted who had gained national recognition through his design of New York's Central Park. Commonwealth Avenue, which had been laid out as part of the Back Bay residential district, and the Public Garden, completed in 1860, were integrated into the park system and parkways, such as the Fenway, Riverway, Jamaicaway and Arborway, served as landscaped connectors between the major parks.[16]

In 1893, the Metropolitan Park Commission (MPC) was founded which, along with other public agencies, acquired most of the parcels lining the Charles River.[17] As a result of a commissioned MPC study investigating the sanitary condition of the Charles River, discussions about whether to construct a dam across the mouth of the Charles River flared up. Several concerns were voiced about the possible silting up of Boston Harbor and the spreading of malaria with a fresh water basin. Some pointed out that industry needed the river access for transporting shipments by water.[18] After years of controversy, however, work on the Charles River Dam was begun and completed in 1910.

The Making of the Esplanade

The Charles River was at the heart of the earliest proposals for a connected series of parks. One of the first people to recognize the Charles River's potential as a public open space asset was Robert Gourlay, a Scottish visionary who proposed that the river be lined with parks and pleasure drives.[19] Charles Eliot believed that the Charles River Basin "was destined to become the central 'court of honor' of the metropolitan district" and the focal point of the entire park system.[20] U.H. Crocker and Charles Davenport had recommended a landscaped embankment along the river even before the 1876 park commissioners' report but it was only in the last years of that century that seawalls were constructed along the Boston shore to increase public open space along the river.[21]

However, the newly created banks on both sides of the river were not developed because of uncertainty regarding the construction of the "Riverbank Subway" and because of opposition from North Beacon Street residents.[22] These property owners were also some of the fiercest opponents of the dam construction at the mouth of the Charles River.

Several schemes had proposed the construction of a row of houses fronting on the basin which would have blocked the river view then enjoyed by water side residents.[23] The outcome was split in that the dam was finally built but the town house construction schemes dropped.

As the newly created basin was not successful in attracting people for leisurely activities[24], several plans, including islands in the Charles, were developed over the following years to increase the basin's appeal. The first stage was the construction of Charlesbank Park in the West End around 1890. It was the first park to be completed in the park system designed by Frederick Law Olmsted. The second stage was the filling of the Charles River between Longfellow Bridge to Charlesgate West at about the time when the dam was built. Embankment Road was laid out as a parkway along the eastern portion of this newly created strip, connecting Beacon and Cambridge Streets. The third stage saw the construction of landscaped edges along the river with little islands and a lagoon, as shown in **Figure B-3**.[25] The park was designed by Arthur Shurcliff in the 1930s and modeled after the Innen Alster Basin in Hamburg, Germany, which had inspired the landscape architect on his recent trip to Europe.[26] Helen Storrow, the widow of James J. Storrow who had been active in getting the dam built, donated one

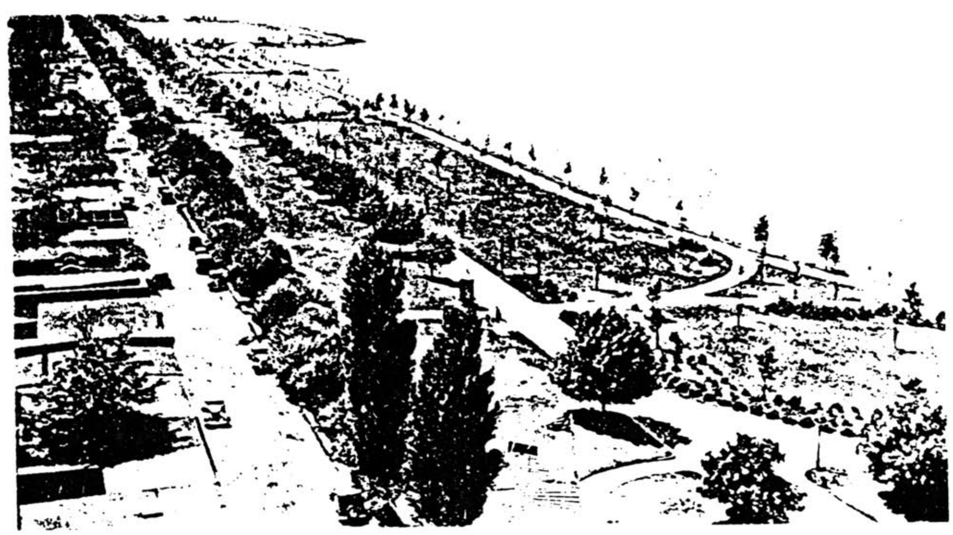


Figure B-3. The Charles River Basin, 1936.

million dollars — over a quarter of the total cost — to aid the development of a riverfront park in memory of her late husband.[27] When the park was completed in the mid-1930s it was named Storrow Memorial Embankment, in memory of its key benefactor, and became what we know today as the River Esplanade, which can be seen in **Figure B-4**.

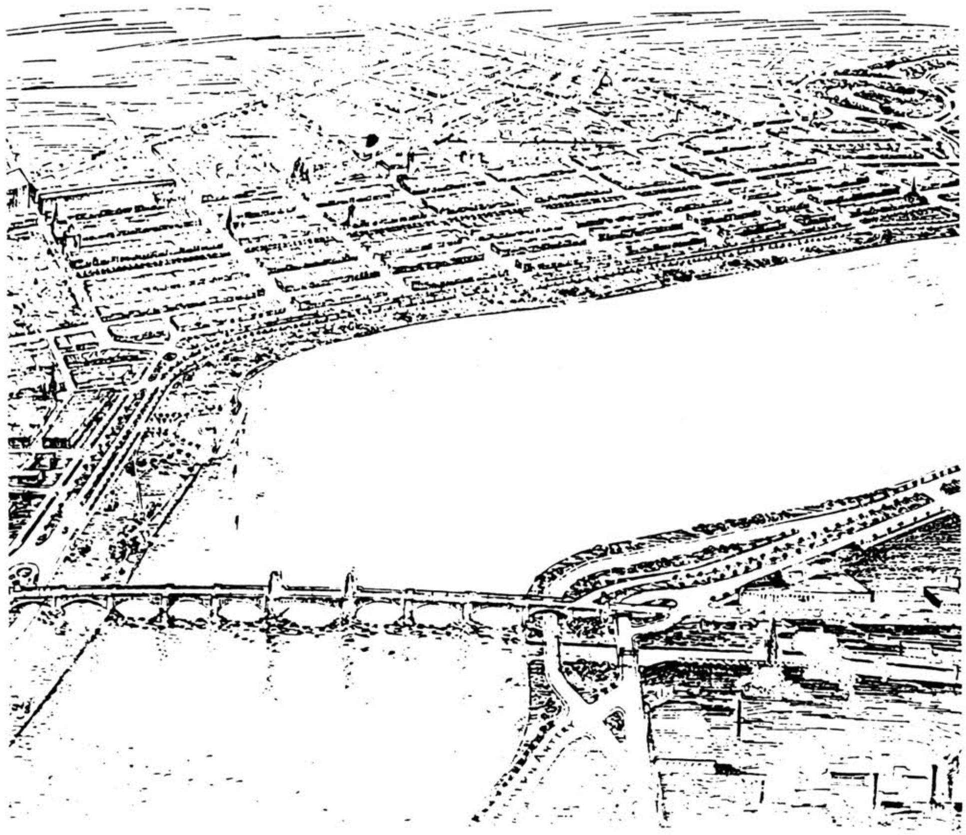


Figure B-4. Perspective of the Charles River Basin, 1929.

Yielding to the Automobile

The establishment of the Esplanade was preceded by years of battles over the construction of a highway on the parkland. In 1929, the recently appointed Special Commission on the Charles River Basin published a report proposing an integrated park and roadway design. The report highlighted that motorists were also park users and that the rather inconspicuous roadway would do little to lessen the enjoyment of the park by pedestrians.[28] Although suggestions for roadways along the Charles River embankments dated back as far as the early BPC reports and had been supported by Charles Eliot and others in the 1890s, there was substantial opposition to these schemes by the 1920s.[29] In a time where cars began replacing trams and carriages as a means of transportation, the role of automobile traffic had changed to such a degree as to dictate the scheme of park design rather than being integrated into it.[30] After an organized battle against the parkway the road construction was eliminated as part of the park proposal.[31]

In spite of the cancellation of the highway plan along the embankment, the city and state continued financing studies supporting the construction of such a roadway.[32] Only a year after the 1929 defeat in the legislature, the *Report on a Thoroughfare Plan for Boston*, more widely known as the "Whitten Report," renewed the idea of a roadway along the south shore of the Charles River. The Whitten Report marks the beginning of a transportation planning approach which became prevalent in the 1950s and 60s. The guiding principle was the provision for "free and continuous movement of traffic [..], relief for congestion and capacity for increases" in the future.[33] Costs of expressway construction were waged against economic benefits deriving from travel time savings and fewer accidents as well as against advancements in the comfort of travel. In order to minimize costs, selected locations for rights-of-way were typically through low-income neighborhoods or public land, often parks, a trend quite visible with road construction schemes in the early postwar years. Environmental and social costs were words of a vocabulary yet to be invented. The report was explicit about stating the dependence of economic prosperity on time- and cost-efficient access between activity points within the metropolitan area.[34]

The automobile was viewed as the harbinger to an era of radically expanding mobility, a quantum leap from the fixed patterns of travel supported by the transit system.[35] The Whitten Report suggested that highway infrastructure needed to be improved so that the city could realize the advantages of automobile transportation.

> "The art of street design and construction has lagged far behind the art of vehicle design and construction. As a result, the citizens and businessmen of metropolitan Boston are denied the full advantage of one of the most marvelous developments of the age, the motor vehicle."[36]

While the Whitten Report still used a parkway design for the express road prototype to run along the river embankment, the Master Highway Plan of 1948 got down to business proposing a "six-lane divided highway of modified limited access design for the use of passenger automobiles."[37] By linking what was then called the Embankment Road Extension to the Central Artery-to-be and Inner Belt-not-to-be and by limiting access and egress points along its alignment, the roadway for the first time was designed as a regional highway link rather than a major parkway such as those girdling the Fenway and Muddy River parks.

Although the Metropolitan District Commission (MDC), a 1919 merger of the Metropolitan Parks and Metropolitan Water and Sewer Commissions, had declared the construction of a highway through the only decade-old Storrow Memorial Embankment to be a "criminal act," it was under their ownership, acquired in 1947, that the highway plans were refined and finally acted upon.[38] The MDC's added responsibilities, primarily in the area of traffic and parking enforcement, led to a reduced commitment to maintain the parks owned by them.[39] The highway proponents, supported by former MDC Commissioner Senator Bowker[40], real estate leaders and the Greater Boston Development Committee, argued that there were strong travel "desire lines" paralleling the Charles River which necessitated the construction of additional capacity along this corridor. The Storrow Memorial Embankment Protective Association, founded in 1948, however, claimed that demand from the West was strongest along an alignment closer to Boylston Street.[41] Nevertheless, committee members, neighborhood residents and activists during the planning phases for the embankment park, could not prevent the passage of the roadway bill in April 1949. With both James and Helen Storrow dead, the roadway opponents had lost two of their most prominent figures and ultimately the park versus freeway battle. Between 1949 and 1951 James J. Storrow Memorial Drive, ironically named after one of its fiercest opponents, was built on the land of the former Memorial Embankment. As compensation, the parkland taken by the new expressway was replaced by an equal amount of new filled river park in the form of little connected islands complementing the former single lagoon.[42]

The Bowker Overpass, constructed in 1965, is the last in the series of infringements upon the Esplanade and its adjacent parks. After the construction of a complicated agglomeration of loops and viaducts at Charles Circle and the completion of high-speed off-ramps from the embankment highway at Arlington Street, a third vital connection to the Esplanade, the Fenway, was now severed. The Emerald Necklace had become brittle.

PART I
A PORTRAIT OF STORROW DRIVE

Understanding the evolution of the Back Bay and Storrow Drive reveals some of the historical controversies surrounding the balance between mobility growth, economic prosperity and the provision of open space. This section of the thesis deals explicitly is one of these, the conflict created by transportation's ambiguous role as both a linkage and a barrier.

Transportation facilities, such as the highway and rail networks, serve to connect people to the locations of their choice. The health and growth of a city depends on a system of efficient linkages which allows for the efficient movement of people and goods. The ability to travel contributes positively to the quality of life in a city.

One of the exciting features of a city such as Boston is its "walkability." Unlike many other settlements in the United States, Boston's scale and land use mix in the vicinity of downtown are some of the primary reasons why walking is so popular and pervasive. In the same ways that the efficient movement of vehicles requires a system of coherent links which are sufficiently sized and interconnected, pedestrians are dependent on such linkages to maintain access to destination points of their choice.

The density of cities typically results in a conflict between achieving adequate mobility for both vehicular and pedestrian travel. Unfortunately, the need to resolve this conflict has often resulted in a hierarchy which benefitted vehicular at the cost of pedestrian mobility. Storrow Drive reflects this hierarchy. While a preferred route by many motorists because of the magnificent views it affords, access to the Esplanade, one of the most vital open space resources in the city and frequent destination for residents of the Back Bay and Beacon Hill, has been severely curtailed through the construction of this limited-access, high-speed expressway.

Storrow Drive, like many other transportation links in the city, dons two hats. One is described in Chapter 1 which provides an overview of vehicular movements and their distribution in Boston and abutting towns with particular focus on the role of Storrow Drive in both the regional and local context. The conflict of vehicular and pedestrian movements at locations along Storrow Drive and its special relation to open space issues, hat number two, are discussed in Chapter 2.

Chapter 1
Transportation As Linkage
System Connectivity and Vehicular Movement

This chapter serves to provide a synopsis of the pattern of vehicular movements in the Boston area. While transit is the principal travel mode for a majority of trips between some areas in the urban core, this paper focusses on the discussion of auto trips. The reason for this is that the *quantitative* analysis of traffic impacts associated with network changes, as will be discussed in Part II, seeks to address the question of how travel by automobile is affected by the configuration of Storrow Drive. The complementary role of transit is always implied and important modal relationships are specifically highlighted and integrated in Part III.

The model network was provided by the Central Transportation Planning Staff and represents a condensed subarea version of CTPS's 877-zone regional model. A description of the this network, the development of a methodology to differentiate between geographic "layers" for analysis, and an overview of road and transit facilities which serve travelers in the Boston area are in section one.

The second section, after a brief discussion of the assignment process, summarizes the results of traffic assignments for the 1987 base year and the future analysis year 2010. Important features of automobile travel in the subregion, an area to be defined below, are discussed with particular focus on the transportation function served by Storrow Drive in both a regional and local context.

1.1. Transportation Network

1.1.1. Model Network and Analysis Areas

The model network used in this paper is a subarea of the CTPS 877-zone Regional Model. Initially prepared for MetroPlan 2000 in 1990, the network covers an area extending a little more than halfway to Route 128, a highway circumferential located approximately 10 miles from downtown Boston. Trips to and from locations outside of this area are represented as external nodes which connect to the 283-zone model network via 65 links at the periphery. Thus, the complete 348-zone model accounts for all trips which have *at least one* trip end in the designated subarea. A map of towns in **Figure 1.1-1** shows the location and size of this area relative to Eastern Massachusetts. The area corresponds to the MPO Commuter Source Area which encompasses the residences of virtually all people who commute to Boston on a daily basis.[43] The model network, depicted in **Figure 1.1-2**, includes the towns of Boston, Brookline, Cambridge, Somerville, Malden, Everett, Medford, Chelsea, Revere and Winthrop.

Figure 1.1-1. Map of Towns in Eastern Massachusetts and Model Subarea.

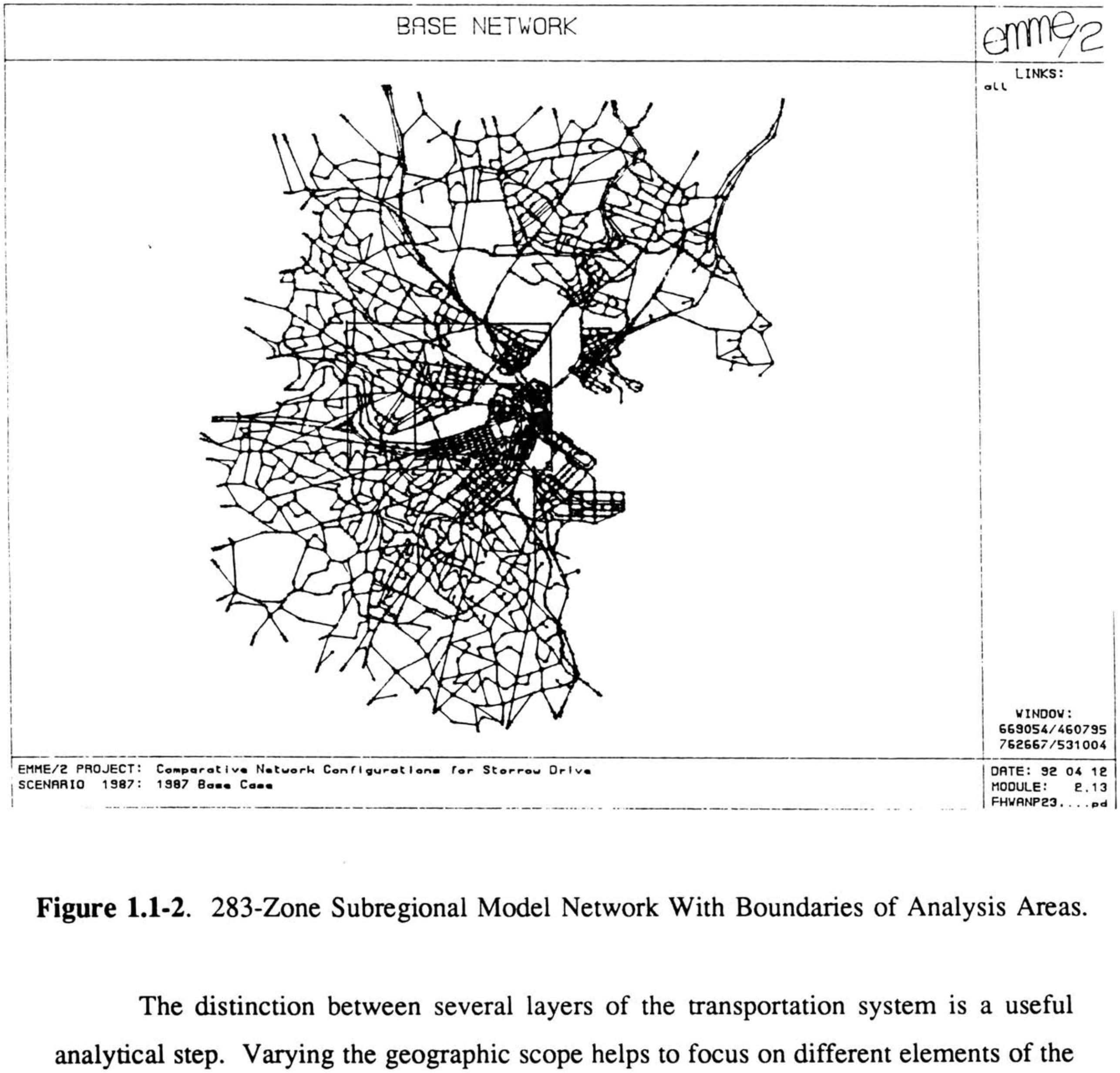


Figure 1.1-2. 283-Zone Subregional Model Network With Boundaries of Analysis Areas.

The distinction between several layers of the transportation system is a useful analytical step. Varying the geographic scope helps to focus on different elements of the highway system, such as hierarchical structure, complementarity and local distribution characteristics.

In this study, the largest area is referred to as the *subregion* which corresponds to the 283-zone subarea of the region. The subregion serves primarily as a wider-scope system reference for the study area and its boundaries coincide with those of the model network as shown in **Figure 1.1-2**.

The *extended core* represents an intermediate area demarcated by Charlestown and

Central Square in Cambridge to the North, Beacon Park to the West, the Fenway to the South and Boston Harbor to the East (**Figure 1.1-3**). This area contains all arterials and highways which are adjacent or parallel to Storrow Drive and seems thus a plausible scale to measure the most immediate automobile traffic impacts of proposed study area network changes as will be seen in Chapter 5.

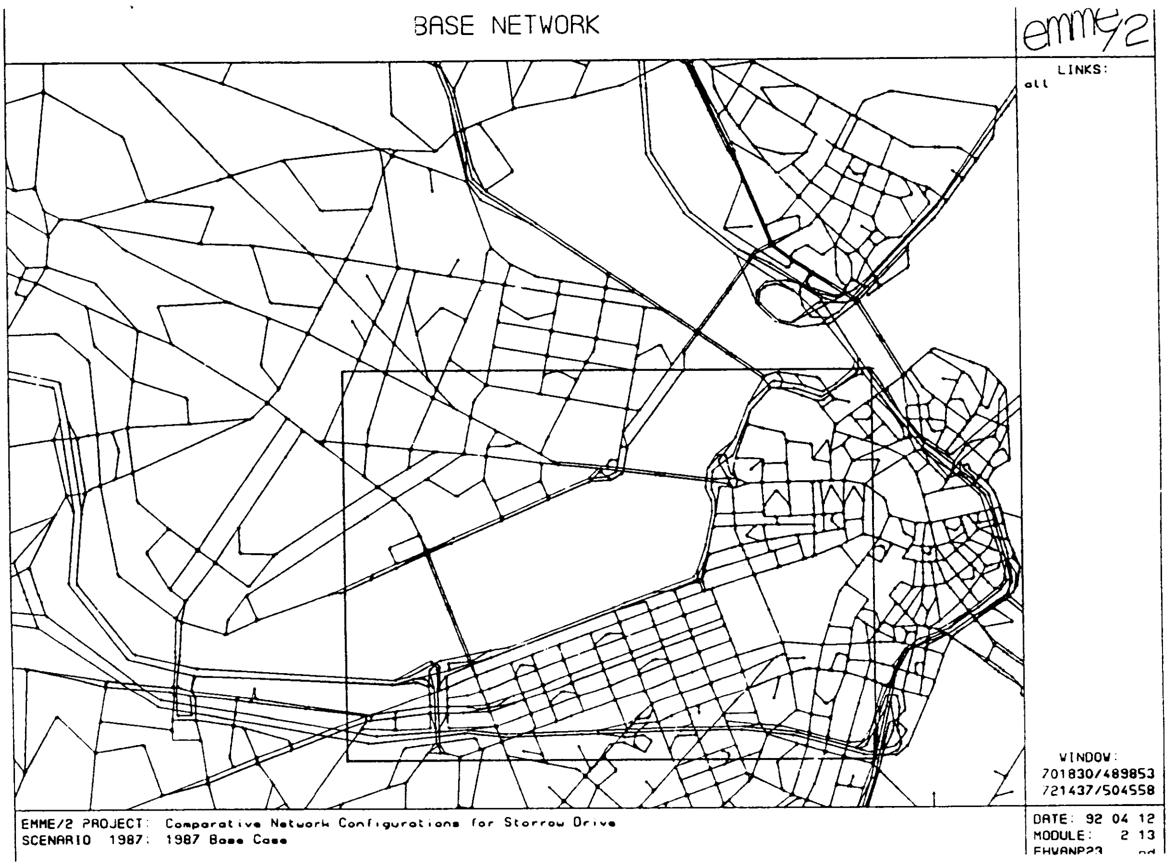


Figure 1.1-3. Extended Core Analysis Area Model Network With Study Area Boundaries.

Finally, the Storrow Drive *study area* itself extends from Charlesgate to the West to Leverett Circle in the Northeast and is shown in **Figure 1.1-4**. All examined network modification options are limited to occur within these boundaries. Within the study area three focal locations — Charles Circle, the Arlington/Berkeley ramp area and Charlesgate — are selected for the more detailed analyses in the following chapters.

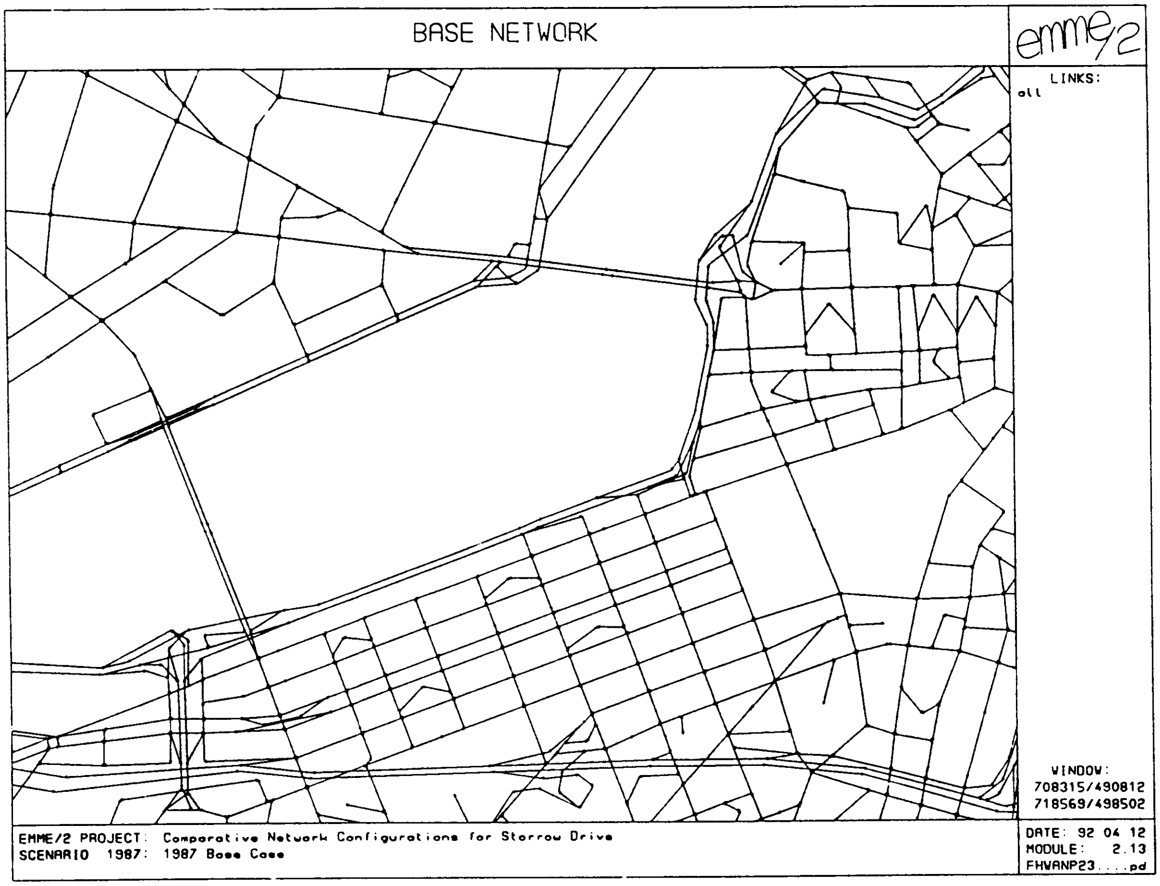


Figure 1.1-4. Study Area Model Network: Leverett Circle to Charlesgate.

1.1.2. Facilities

The facilities serving these movements are the underlying grid of the transportation system. **Figure 1.1-5** shows a roadway map of the subregion. It shows that Boston has a typical radial highway system with few circumferential connections within Route 128. Access from the Southeast occurs primarily via the Southeast Expressway (I-93 South) and major arterials such as Route 28 South and Dorchester Avenue. From the Southwest, vehicles could use either the Worcester Turnpike (Route 9) or major arterials, such as Beacon Street or parkways lining the Emerald Necklace. The Massachusetts Turnpike is a major transportation corridor extending to the West and supported by several smaller

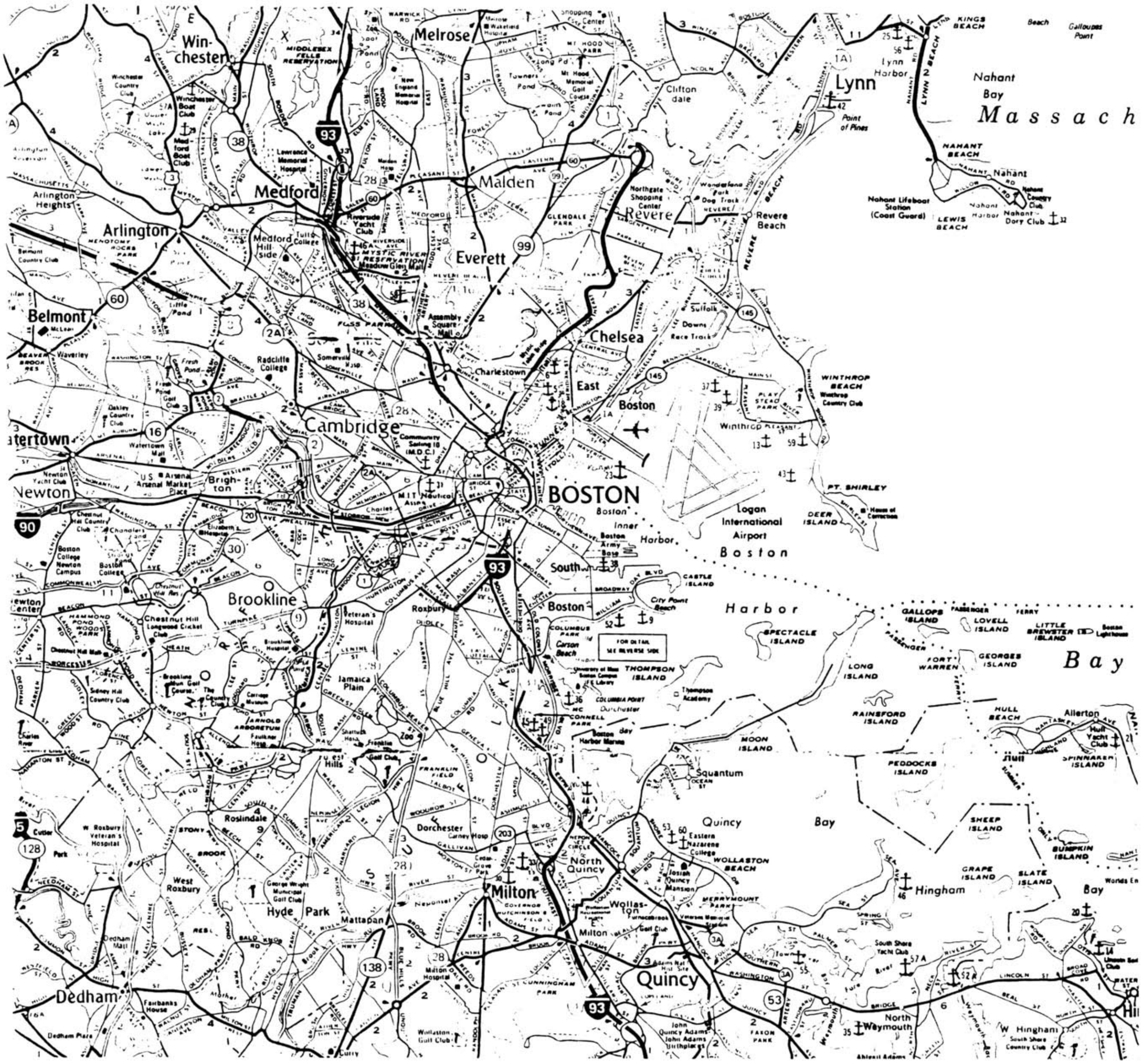


Figure 1.1-5. Roadway Map of Boston and Vicinity.

arterials most of which feed into Soldiers Field Road and Memorial Drive further in. In the Northwest, Route 2 and Cambridge arterials such as Concord and Massachusetts Avenue represent the most important roadway corridors as do I-93 and Route 28 to the North. Finally, Routes 1 and 1A are the principal highway connections to the Northeast. Principal highway and arterial connections to Boston within the subregional system are schematically depicted in **Figure 1.1-6**.

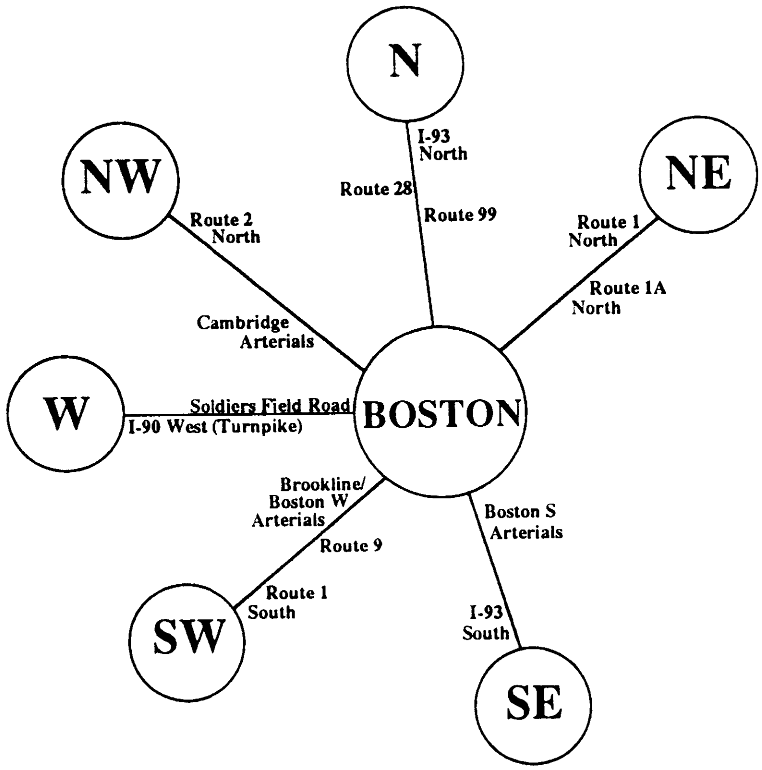


Figure 1.1-6. Schematic Overview of Principal Road Connections in Subregion.

Within the extended core area, it is useful to distinguish between primary and secondary highways. The primary highways are the Central Artery, the Massachusetts Turnpike, McGrath Highway and Storrow Drive. These are limited-access facilities without or with little signal control which have very high capacities. The second group comprises of major arterials such as Somerville and Massachusetts Avenue, Cambridge Street, Broadway and Memorial Drive in Cambridge, and Brookline and Beacon Streets, Huntington Avenue, Tremont Street and the Fenway in Boston. For clarity, these are again shown in a schematic overview in **Figure 1.1-7**.

Storrow Drive is a limited-access, six-lane highway within the study area and four lanes wide further to the West. It connects suburbs in the West and Northwest via Route 2 and other arterials, suburbs in the South and Southwest via the parkways and Route 9, as well as activity centers in the Back Bay, Beacon Hill, Government Center and other downtown locations with the Interstate system at Beacon Park, the I-90 West linkage, and at Leverett Circle, the I-93 linkage. The principal nodes at which these connections occur are the interchange at Soldiers Field, Beacon Park, Charlesgate, the Arlington/Berkeley ramp area, Charles and Leverett Circle, the latter four of which are included in the study area. The schematic diagram in **Figure 1.1-8** shows which areas are served by Storrow Drive and the nodes at which they occur. With the ongoing debate about a design for the proposed river crossing, and exploration of improvement possibilities of the Allston Interchange at Beacon Park, the study area lies in between two areas which will undergo substantial transformation over the next years.

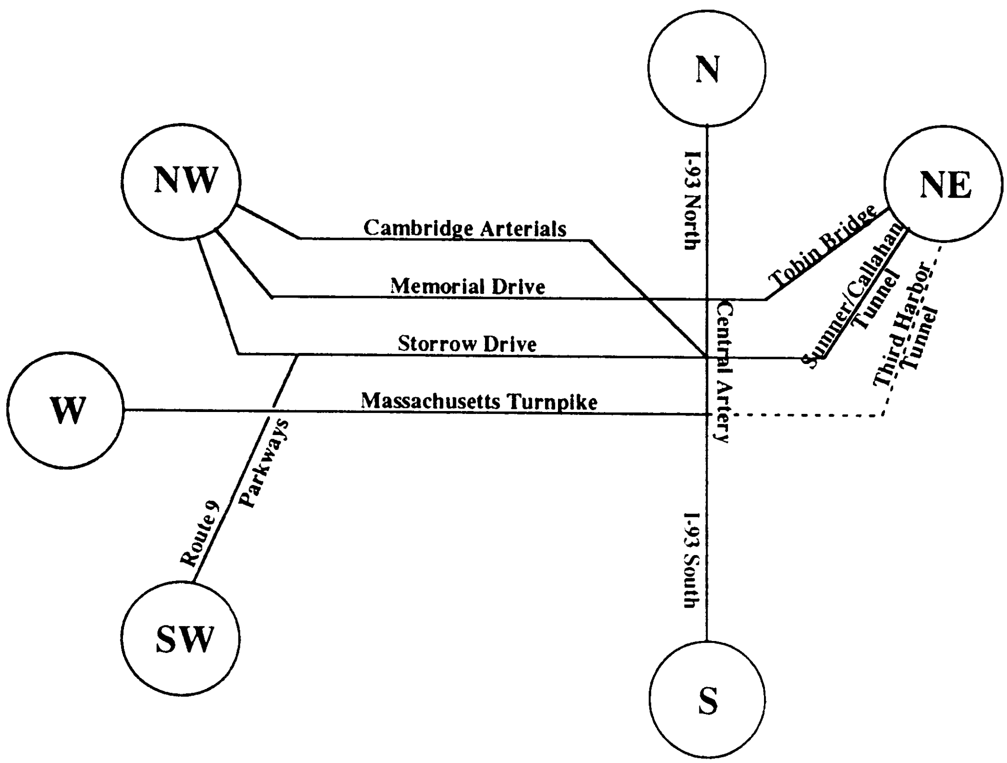


Figure 1.1-7. Schematic Overview of Principal Road Connections in Extended Core.

On the transit side, **Figures 1.1-9a** and **1.1-9b** give an overview of the subregional rapid transit and commuter rail system. The Massachusetts Bay Transportation Authority operates four rapid transit lines, the Red, Blue, Green and Orange lines, as well as ten commuter rail branches out of North and South Station in Boston. A closer view of

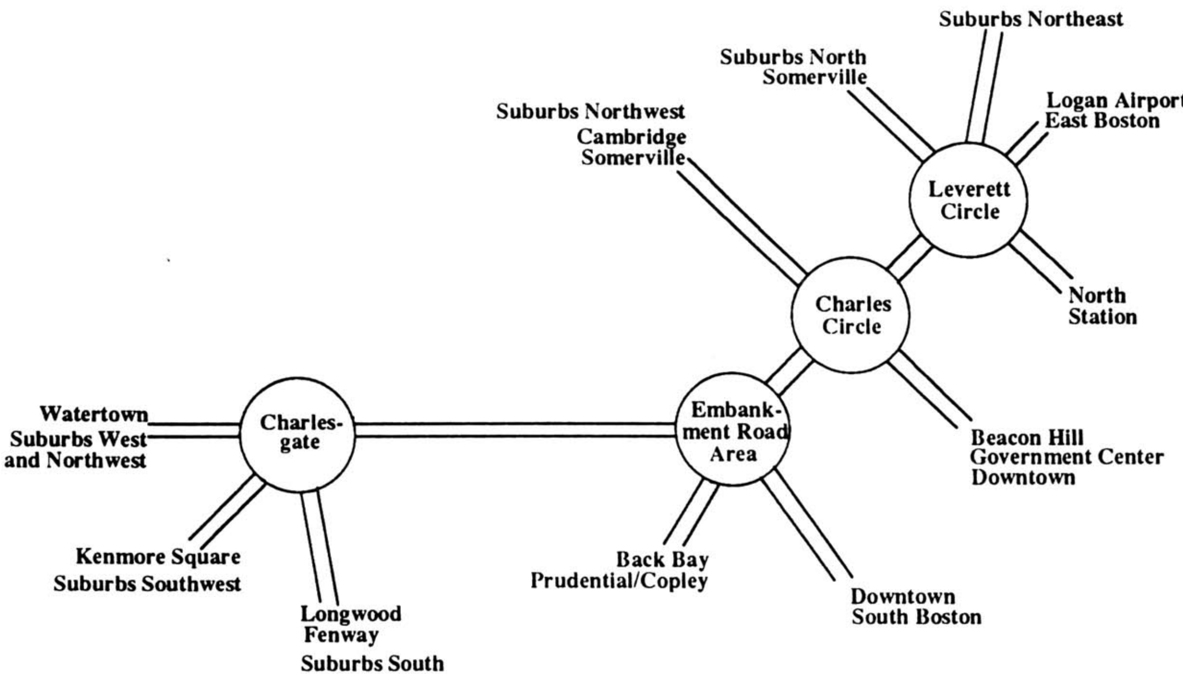


Figure 1.1-8. Schematic Overview of Study Area And Identification of Key Nodes.

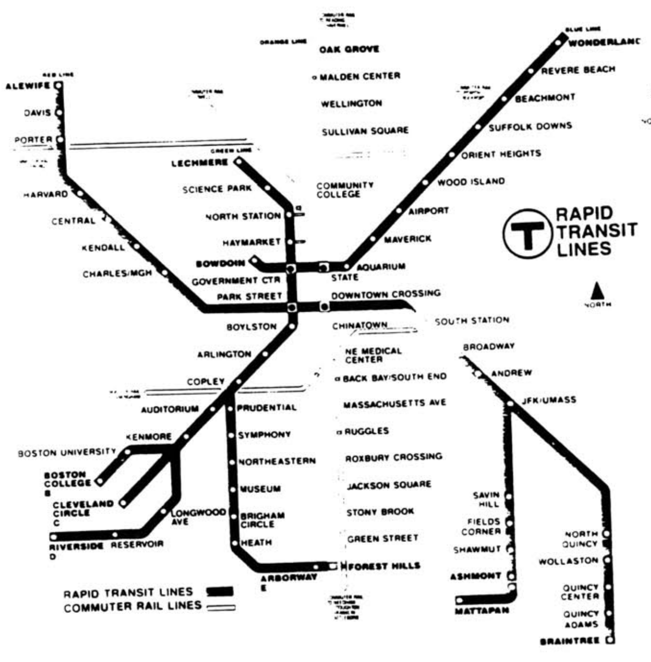


Figure 1.1-9a. MBTA Rapid Transit Lines.

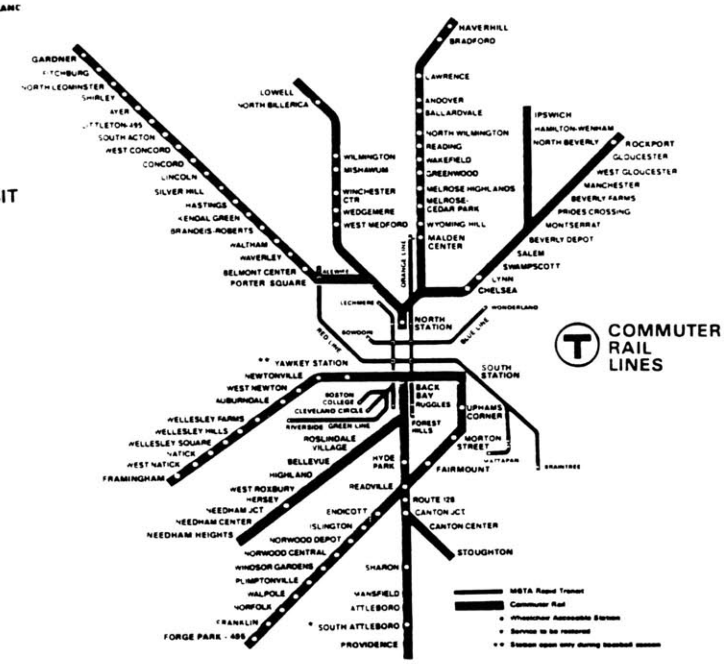


Figure 1.1-9b. MBTA Commuter Rail Lines.

transit alternatives in the adjacency of the study area are shown in **Figure 1.1-10**. As is evident from this graphic, all bus, rapid transit and commuter lines are located close to the commercial area on the southern end of the Back Bay. Not depicted in this figure are the rapid transit Red Line connection at Charles and the Green Line connection at Leverett Circle.

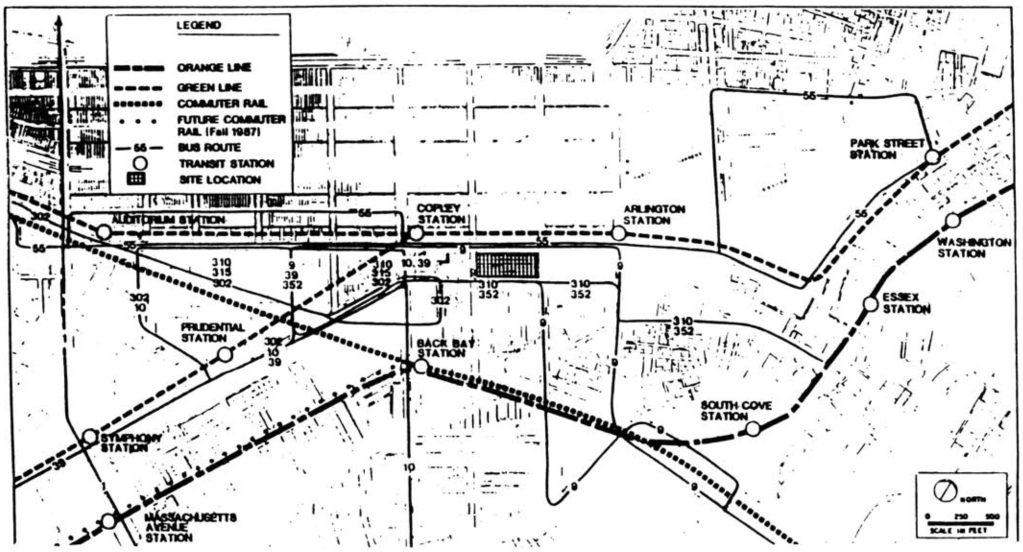


Figure 1.1-10. Overview of Public Transit Facilities in the Back Bay.

1.2. Automobile Travel

This section summarizes the results of traffic assignments performed on the 1987 and 2010 network with the respective trip tables. A brief discussion of the assignment process and underlying assumptions is followed by a graphic, tabular and written description of vehicular traffic volumes on the three analysis levels and changes occurring between 1987 and 2010.

1.2.1. Trip Tables and Network Equilibrium Assignments

The trip tables, which means the sum of all trips to all origins within the 348-zone network — 283 zones in the subregion and 65 external nodes — were generated by CTPS from the 877-zone Regional Model with a subarea extraction program which aggregates trips to and from outside the subarea network. The trip table accounts for all trips which occur within the subregion and those crossing its boundaries *at least once*. Initially prepared for MetroPlan 2000, the demand matrix, as trip tables are commonly referred to, includes trips by private car, truck and taxi. The generation of the 2010 trip tables was based on the assumption that several transit improvements would be in place.[44]

The process of calculating how trips which have fixed origins and destinations are distributed across links in the network is called a traffic assignment. Traffic assignments are based on a network equilibrium model which applies a mathematical formula to calculate link impedances from variables such as link volume, lane capacity, number of lanes and free-flow speeds (approximately the speed limit). Link impedance is a variable denoting the facility with which a link can be traversed. Above a certain threshold, additional vehicles will slow down traffic on a link which is reflected in the volume-delay function. The equilibration process then finds the shortest time path between any origin-destination pair according to link impedances updated by an iterative assignment process with the volume-delay function.

1.2.2. Presentation Format

The result of this process is completed traffic assignments which allocate the respective vehicle volumes to each link within the network. This information can be presented in various formats to allow different elements to be extracted for analysis.

One form of illustration is *network plots* depicting traffic volumes on the whole set or a subset of roadways in the analysis area under consideration. Network plots are used on all three analysis levels. While this form of presentation is less useful for detailed comparisons of traffic volumes at specific locations, it is the most graphic for the visualization of approximate relationships of travel volumes within the system.

A second format is the tabulation of traffic volume measurements in selected *spot locations*. For some of these, roadside counts from the Department of Public Works (DPW) are included which help to assess the accuracy of the model estimates deriving from the assignment process. Spot location counts are used for all three analysis levels.

The tabulation of *screenline counts* is another traffic volume measurement format. Here, traffic volumes passing through a coherent set of adjacent cordon points, called a screenline, are added to provide an estimate of the number of vehicles entering and leaving a designated subarea from a particular direction of the metropolitan area. Screenline counts are a tool for measuring flows on a larger scale and are thus used for the subregional analysis area.

Fourth, *corridor counts* are performed for key corridors and some of their access/egress ramps in the extended core area. The Central Artery and Massachusetts Turnpike in Boston as well as Memorial Drive in Cambridge are subjected to closer scrutiny because of their special relationship to Storrow Drive. The Central Artery and Turnpike are the major highways which serve downtown destinations and have regional transportation functions. Memorial Drive, on the other hand, is a complementary roadway to Storrow Drive/Soldiers Field Road as it runs parallel in its entirety and might be used as an alternative route for both local and regional trips.

Finally, in a *labeled links* presentation, a network section is shown along with its link volumes. Because of the large amount of information contained in such a plot it is only useful for small subareas of the network and is therefore applied only in section 3.

1.2.3. The Subregion

As described above, the model network area, referred to as the subregion, consists of 283 zones with 65 external nodes. The links connected to the external nodes measure influx into and outflux from the model network area. A total of more than 2,500,000 vehicle trips occur on an average weekday (AWDT) in 1987 on the roads of the model network. Of these trips, less than 30% originate in areas outside of the subregion and less than 12% of this subgroup also has their destinations outside of the subregion. This means that less than 3.5% of all these trips have origins *and* destinations outside of the subregion and merely pass through the model network.

As can be seen from **Figure 1.2-1**, showing 1987 auto volumes, automobile travel in the subregion is concentrated along selected corridors. With roadways carrying less than 10,000 vehicles daily in each direction suppressed in this graphic for legibility, one can identify the major volume-carrying highways in the network.

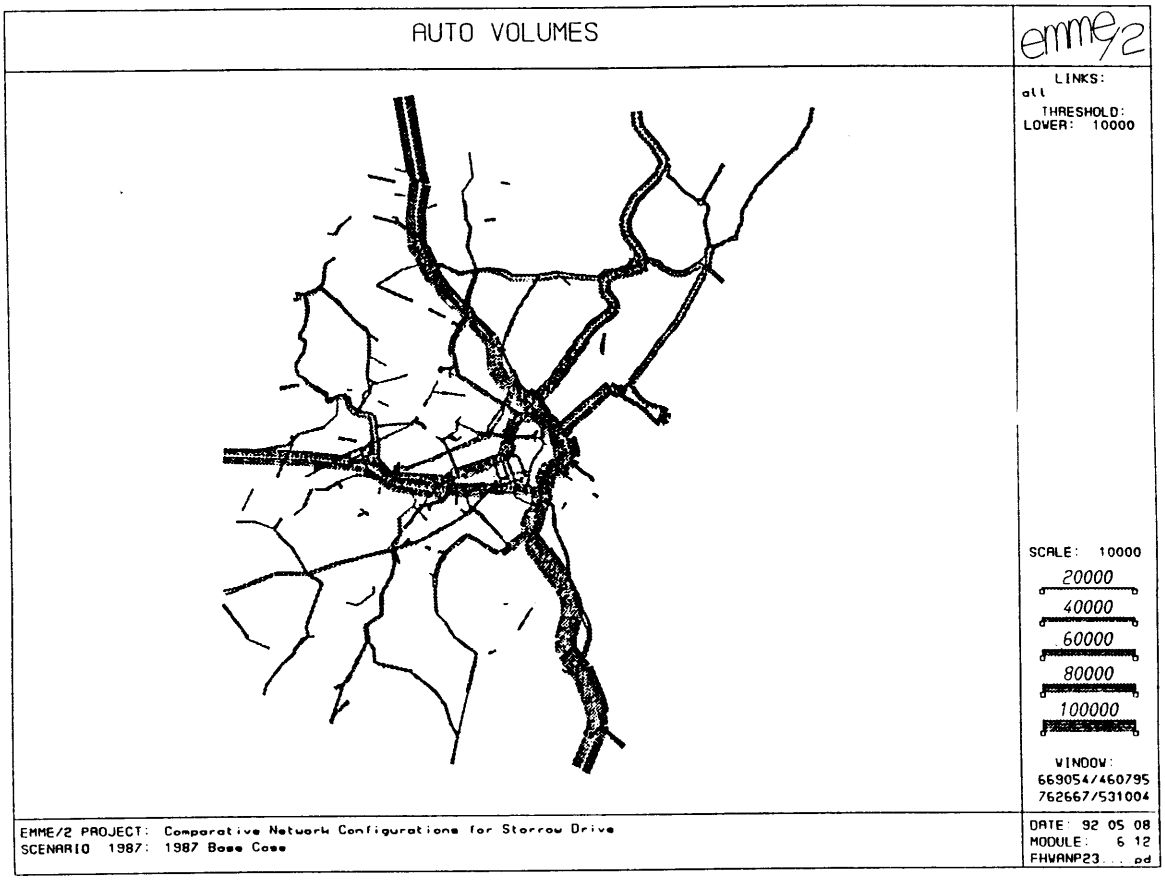


Figure 1.2-1. 1987 AWDT Volumes in Subregion on Links With > 10,000 Vehicles.

Clearly, Interstate 93 serves as the primary regional North-South link. Routes 1 and 1A are principal connectors to the Northeast while the Massachusetts Turnpike, Interstate 90, is the main travel corridor to the West. Routes 28 and 99 appear as other key highway links in the subregional network from the North as does Route 2 from the Northwest. Route 28, the McGrath Highway, feeds into the Msgr. O'Brien Highway in Cambridge while Route 2 is one of the principal feeders of Soldiers Field Road and Storrow Drive. Other large volume-carrying arterials in Cambridge include Massachusetts Avenue (Route 2A), River Street, Western Avenue and Memorial Drive. Route 16 in the North and, to a limited extent, Route 2A in Cambridge, appear to be the only larger-volume highways serving a circumferential function within the subregion.

Since construction of the Southwest Expressway was stopped in the early 1970s, no equivalent corridor exists in the Southwest and traffic volumes are distributed among several smaller highways and arterials, among which are the Worcester Turnpike (Route 9) leading into Huntington Avenue, Route 1 leading into Lee Street, Route 9 and into the parkway system, Hyde Park Avenue leading into Route 9 and the parkways, and Route 28, Blue Hill Avenue, leading into Columbus Avenue and Melnea Cass Boulevard.[45]

2010 is the selected future analysis year. Total vehicle trips in the region are forecast to increase by more than 18% to over 3 million on an average weekday. Of these, less than 30% have origins outside of the subregion and less than 5.5% are through trips. As can be seen in **Figure 1.2-2**, the 2010 equivalent of **Figure 1.2-1**, there are no

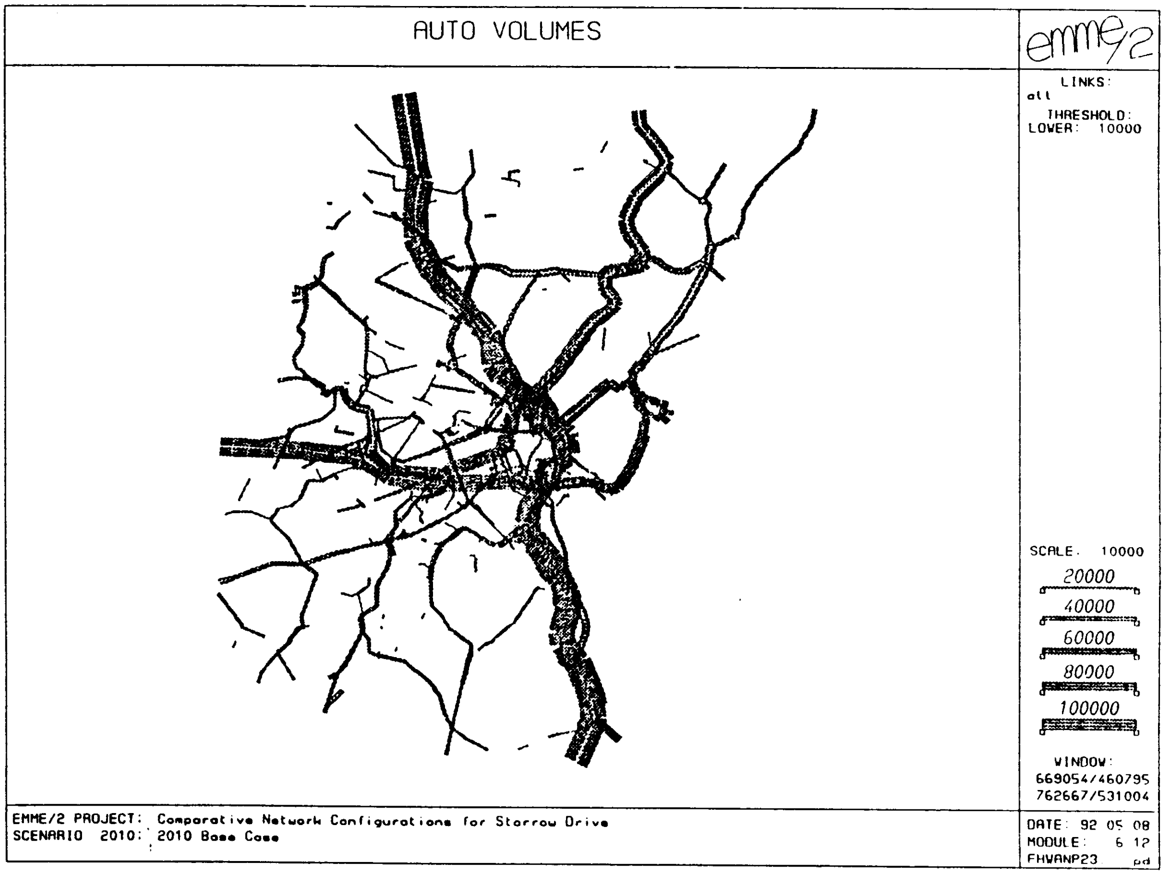


Figure 1.2-2. 2010 AWDT Volumes in Subregion on Links With > 10,000 Vehicles.

significant shifts in corridor volumes beyond the expected linear increases.[46] Two important exceptions are visible, however, which derive directly from the completion of the Central Artery/Third Harbor Tunnel (CA/T) project. One is the increase in volumes along most of the I-93 alignment which is facilitated by the elimination of the central bottleneck. Another is the addition of the Third Harbor Tunnel which carries about 50,000 vehicles every day in each direction.

To give an approximate picture of the change in number of automobiles entering the subregion at specific locations, volumes at peripheral spot locations for 1987 and 2010 are listed in **Table 1.2-1**. The area is roughly divided into five quintants and traffic count locations are selected based on two criteria. One is, that they be located *inside* some of the most peripheral decision points in our model network, another that they be major access routes. The selection is based on the rationale that if volume shifts occur as a result of changes in the facility with which former routes are used, the impact at the periphery can be best evaluated at locations where drivers select one route over another based on their destination and their new estimate of the quickest possible path.

Morrissey Boulevard, the Massachusetts Turnpike, Memorial Drive, Beacon Street, McGrath/O'Brien Highway, I-93 North and Route 1A North all show increases in excess of 30% at the specified locations between 1987 and 2010, or more than 1.5 times the average system increase. Morrissey Boulevard runs parallel to the Southeast Expressway and the large increase could be attributable to the fact that vehicles use it as an overflow facility to the non-expanded segments of I-93 South and access the Central Artery at ramps close to where it will be widened near downtown. The Massachusetts Turnpike, I-93 North and Route 1A North have increases in volumes as a direct result of the Central Artery capacity expansion, the revised I-90/I-93 interchange, and the addition of the Third Harbor Tunnel. Large increases on the McGrath/O'Brien Highway in Cambridge could be the result of a better Interstate connection in the Charlestown area which facilitates egress from the Central Artery to surface arterials. Finally, the significant increase on Memorial Drive at its western end might be attributable to an increased use of the Beacon Park access to the Massachusetts Turnpike. All other volume increases, with the exception of Beacon Street in Brookline, are within 50% of the average system travel growth of 18%.

	LINK	1987	2010	DIFF
Southeast				
Morrissey Blvd N of Dudley St				
Northbound	2798-3805	17,260	29,400	+70.3%
Southbound	3804-3005	15,828	27,140	+71.5%
Total		33,088	56,540	+70.9%
I-93 S of Mass Ave exit				
Northbound	1702-1704	91,055	108,313	+19.0%
Southbound	1715-1716	91,552	111,079	+21.3%
Total		182,607	219,392	+20.1%
Seaver St N of Blue Hill Ave				
Northbound	3029-1641	13,604	15,741	+15.7%
Southbound	1641-3029	13,906	15,814	+13.7%
Total		27,510	31,555	+14.7%
average increase				*+26.4%*
Southwest				
Huntington Ave E of Jamaicaway				
Eastbound	2717-2716	19,909	21,584	+8.4%
Westbound	2716-2717	17,479	21,554	+23.3%
Total		37,388	43,138	+15.4%
Jamaicaway N of Huntington				
Northbound	2718-2725	18,366	20,859	+13.6%
Southbound	2725-2718	18,136	20,213	+11.5%
Total		36,502	41,072	+12.5%
Beacon St E of Harvard Ave				
Eastbound	5316-5314	8,601	12,596	+46.4%
Westbound	5314-5316	6,994	10,316	+47.5%
Total		15,595	22,912	+46.9%
average increase				*+19.7%*
West				
Turnpike E of Beacon Park				
Eastbound	5484-5485	64,667	80,277	+24.1%
Westbound	5486-5483	58,823	76,658	+30.3%
Total		123,490	156,935	+27.1%
Soldiers Field Road S of Western Ave Bridge				
Eastbound	5416-5417	24,164	27,249	+12.8%
Westbound	1824-1825	21,507	23,560	+9.5%
Total		45,671	50,809	+11.3%
Memorial Drive E of L. Anderson Bridge				
Eastbound	4414-4415	3,650	5,620	+54.0%
Westbound	4415-4414	6,863	9,283	+35.3%
Total		10,513	14,903	+41.8%
Mass Ave N of Waterhouse St				
Northbound	4387-4388	17,050	18,721	+9.8%
Southbound	4388-4387	16,131	17,990	+11.5%
Total		33,181	36,711	+10.6%
average increase				*+14.6%*
Northwest				
Somerville Ave E of Porter Square				
Eastbound	4389-3519	10,916	12,445	+14.0%
Westbound	3519-4389	10,520	11,331	+7.7%
Total		21,436	23,776	+10.9%
McGrath Hwy @ Washington St Overpass				
Northbound	5258-5245	13,613	19,185	+40.9%
Southbound	5246-5259	14,487	16,211	+11.9%
Total		28,100	35,396	+26.0%
O'Brien Hwy. W of 2nd St				
Northbound	5264-3543	23,887	27,639	+15.7%
Southbound	3542-5265	17,449	24,658	+41.3%
Total		41,336	52,297	+26.5%
I-93 S of Sullivan Square				
Northbound	5174-5176	70,778	99,064	+40.0%
Southbound	5175-5173	62,634	104,754	+67.2%
Total		133,412	203,818	+52.8%
Sullivan Square Overpass				
Northbound	3459-3461	9,868	11,933	+20.9%
Southbound	3462-3460	10,274	14,606	+42.2%
Total		20,142	26,539	+31.8%
average increase				*+39.8%*
Northeast				
Tobin Bridge (Route 1 North)				
Northbound	1840-1841	56,619	68,906	+21.7%
Southbound	1652-1839	54,999	63,968	+16.3%
Total		111,618	132,874	+19.0%
Route 1A @ Boston Revere Line				
Northbound	3791-3787	27,814	33,966	+22.1%
Southbound	4756-3790	22,793	34,830	+52.8%
Total		50,607	68,796	+35.9%
average increase				*+24.3%*

Table 1.2-1. 1987 and 2010 AWDT Volumes at Selected Peripheral Spot Locations.

While large increases in throughput on portions of the Interstate highways could be achieved as a result of the elimination of an existing bottleneck along the Central Artery and Bridge, no commensurate capacity expansions on Cambridge and Boston arterials will occur. Therefore, it is unclear how the projected growth in vehicle-miles travelled (VMT) could actually be absorbed by the road network. Considering the current levels of traffic on most of these roads, it seems highly unlikely that these increases could actually occur as forecasted by the model.

Screenline counts show the distribution of trips into and from a selected area among the major and minor roadways crossing this line. **Table 1.2-A1**, included in the appendix, shows traffic counts and assigned volumes for the analysis years 1987 and 2010. For comparison, both the results of my own model runs and those conducted by CTPS on the 877-zone Regional Model are listed. As can be seen from the table, with few exceptions the assignment results are very close.[47]

Discounting potentially unreliable assignment estimates,[48] the largest increases in traffic volumes, both in terms of number of vehicles and percentages, can be observed on the Turnpike, the Central Artery, I-93 North and South, the Tobin Bridge, the Surface Artery, Routes 99 and 28 North and at the Harvard and Chelsea Bridges for observations at various screenline locations. As pointed about above, most of these increases are directly linked to the capacity expansion of the Central Artery and the addition of a third tunnel under Boston Harbor.

While traffic assignments typically cannot exactly replicate the observed counts along a selected link, the table illustrates that in general over- and under-assignments approximately cancel out sufficiently to deliver screenline volume estimates which are within 10% of the actual counts.[49]

Table 1.2-2 is a summary of selected screenline counts from **Table 1.2-A1** in the appendix. It shows the number of trips entering and leaving central Boston at the Southampton Street-Massachusetts Avenue-Charles River-Boston Harbor contiguous screen "ring" for both 1987 and 2010. As can be seen from this table, trips into and out

	LINK	1987	2010	DIFF
Screenline West (Mass Ave)				
Albany St E of Mass Ave				
Eastbound	2432-3133	5,513	5,465	-0.9%
Westbound	3133-2432	4,121	5,384	30.6%
Total		9,634	10,849	12.6%
Harrison Ave E of Mass Ave				
Eastbound	2431-2430	3,670	4,166	13.5%
Westbound	2430-2431	5,385	6,414	19.1%
Total		9,055	10,580	16.8%
Washington St E of Mass Ave				
Eastbound	2429-3151	2,270	3,908	72.2%
Westbound	3151-2429	1,659	2,317	39.7%
Total		3,929	6,225	58.4%
Shawmut St E of Mass Ave				
Westbound	2427-2428	1,705	1,128	-33.8%
Tremont St E of Mass Ave				
Eastbound	2426-2425	5,778	6,538	13.2%
Westbound	2425-2426	5,903	8,457	43.3%
Total		11,681	14,995	28.4%
Columbus Ave E of Mass Ave				
Eastbound	2424-2370	7,320	8,551	16.8%
Westbound	2370-2424	8,358	8,188	-2.0%
Total		15,678	16,739	6.8%
Huntington St E of Mass Ave				
Eastbound	2423-2290	12,977	12,648	-2.5%
Westbound	2290-2423	15,219	15,353	0.9%
Total		28,196	28,001	-0.7%
Belvedere St E of Mass Ave				
Westbound	2293-2421	1,651	2,330	41.1%
Boylston St E of Mass Ave				
Eastbound	2420-2245	6,619	8,300	25.4%
Westbound	2245-2420	2,636	2,537	-3.8%
Total		9,255	10,837	17.1%
Newbury St E of Mass Ave				
Westbound	3234-3236	4,892	3,756	-23.2%
Comm Ave E of Mass Ave				
Eastbound Loc	3237-3109	548	950	73.4%
Eastbound Thru	3421-3109	6,363	7,065	11.0%
Westbound Loc	3108-3399	1,003	862	-14.1%
Westbound Thru	3108-3238	6,194	7,846	26.7%
Total		14,108	16,723	18.5%
Marlborough St E of Mass Ave				
Eastbound	3401-3400	1,068	903	-15.4%
Beacon St E of Mass Ave				
Westbound	3403-3402	3,959	5,599	41.4%
Storrow Drive E of Mass Ave				
Eastbound	3404-2464	52,154	58,014	11.2%
Westbound	2463-3065	55,017	60,664	10.3%
Total		107,171	118,678	10.7%
Turnpike E of Mass Ave				
Eastbound	5488-3425	64,667	80,277	24.1%
Westbound	2408-2409	55,521	72,728	31.0%
Total		120,188	153,005	27.3%
TOTAL EASTBOUND		168,947	196,785	16.5%
TOTAL WESTBOUND		173,223	203,563	17.5%
Screenline North (Charles River)				
Longfellow Bridge				
Northbound	2160-2161	15,863	16,671	
Southbound	2162-2163	14,623	16,963	
Total		30,486	33,634	
Charles River Dam				
Northbound	2135-2136	21,410	27,674	
Southbound	2137-2138	30,387	32,430	
Total		51,797	60,104	

	LINK	1987	2010	DIFF
Screenline North (continued)				
Artery Bridge				
Northbound	2113-1834	88,823	133,561	50.4%
Southbound	1833-2116	90,342	140,087	55.1%
Total		179,165	273,648	52.7%
"Leverett Bridge"				
Northbound	6251-6447	n/a	73,685	
Southbound	6444-6445	n/a	74,846	
Total		n/a	148,531	
Charlestown Bridge				
Northbound	3395-3396	32,308	32,282	-0.1%
Southbound	3397-3398	31,464	26,713	-15.1%
Total		63,772	58,995	-7.5%
TOTAL NORTHBOUND		158,404	283,873	79.2%
TOTAL SOUTHBOUND		166,816	291,039	74.5%
Screenline East (Boston Harbor)				
Callahan Tunnel				
Eastbound	5499-5496	55,928	43,043	-23.0%
Sumner Tunnel				
Westbound	5497-5498	52,691	44,819	-14.9%
Total		108,619	87,862	-19.1%
Third Harbor Tunnel				
Eastbound	6398-6399	n/a	52,090	
Westbound	6413-6415	n/a	50,217	
Total		n/a	102,307	
TOTAL EASTBOUND		55,928	95,133	70.1%
TOTAL WESTBOUND		52,691	95,036	80.4%
Screenline South (Southampton St)				
William Day Blvd. S of Columbia Rd				
Northbound	4166-4168	3,386	3,309	-2.3%
Southbound	4168-4166	3,119	2,956	-5.2%
Total		6,505	6,265	-3.7%
Old Colony Ave N of Southampton St				
Northbound	4159-4160	13,570	22,005	62.2%
Southbound	4160-4159	16,392	15,739	-4.0%
Total		29,962	37,744	26.0%
Boston St N of Southampton St				
Northbound	3599-4143	3,352	3,359	0.2%
Southbound	4143-3599	4,542	3,629	-20.1%
Total		7,894	6,988	-11.5%
Dorchester Ave N of Southampton St				
Northbound	3599-4139	4,340	4,283	-1.3%
Southbound	4139-3599	5,219	2,753	-47.3%
Total		9,559	7,036	-26.4%
Frontage Rd N of Southampton				
Northbound	3604-3606	7,220	8,653	19.8%
Southbound		n/a	28,165	
Total		7,220	36,818	409.9%
Southeast Expressway @ Southampton St				
Northbound	2556-2557	102,802	118,283	15.1%
Southbound	2544-2550	95,524	109,809	15.0%
Total		198,326	228,092	15.0%
Melnea Cass Blvd NE of Mass Ave				
Eastbound	2436-1660	34,937	27,564	-21.1%
Westbound	1663-2435	34,969	27,505	-21.3%
Total		69,906	55,069	-21.2%
TOTAL NORTHBOUND		169,607	187,456	10.5%
TOTAL SOUTHBOUND		159,765	190,556	19.3%
Intermediate Ring Screenline Summary				
TOTAL TRIPS IN		505,370	675,280	33.6%
TOTAL TRIPS OUT		491,392	677,992	38.0%

(Year 2010 volumes include double river crossing for Leverett)

Table 1.2-2. 1987 and 2010 AWDT Volumes at Intermediate Screen "Ring" Locations.

of this area increase by about 35% between 1987 and 2010. However, discounting the double crossing of the Charles River for the Leverett connection under this design, Scheme Z at the time the network was coded, the increases is only about 21%, close to the system average of 18%. The screenline locations of this ring are shown in **Figure 1.2-3.**

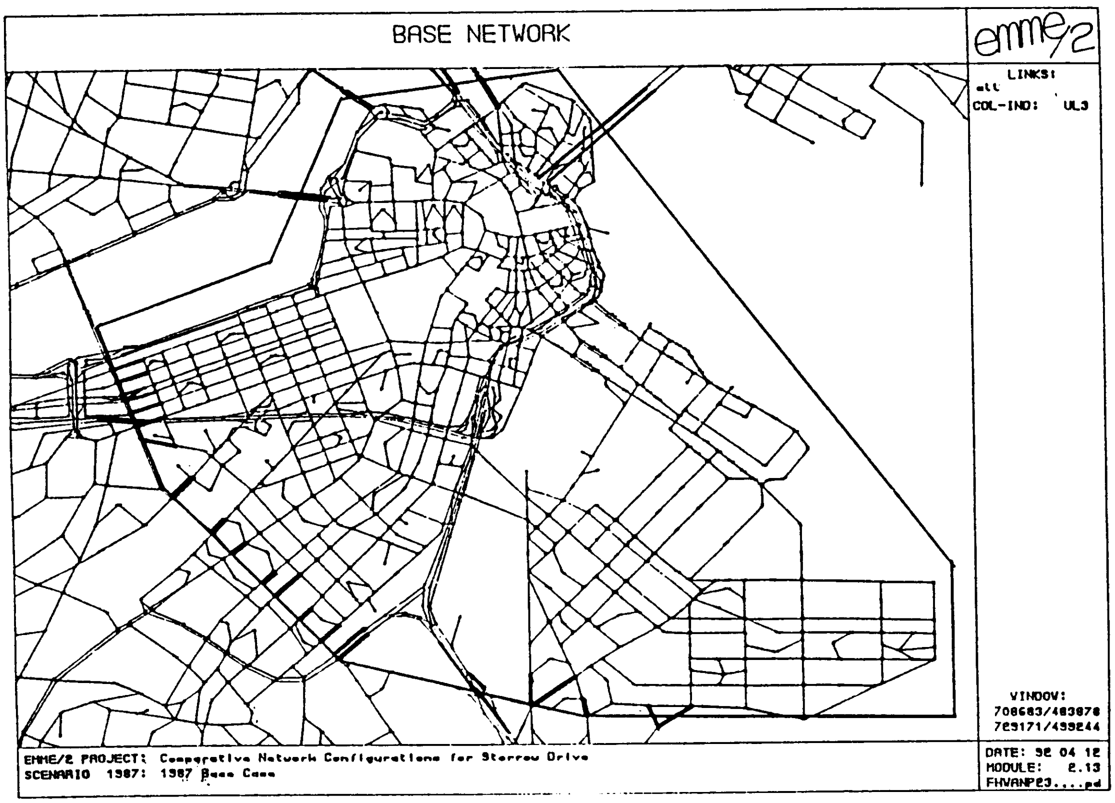


Figure 1.2-3. Overview of Screen "Ring" Cordon Locations.

1.2.4. The Extended Core

A more detailed view of traffic volumes in closer proximity to the study area is shown in **Figure 1.2-4** for 1987 and **Figure 1.2-5** for the year 2010. This extended core area comprises of roadways in the vicinity of the study area where traffic volumes are likely to be most directly affected by possible changes to the configuration of Storrow Drive.

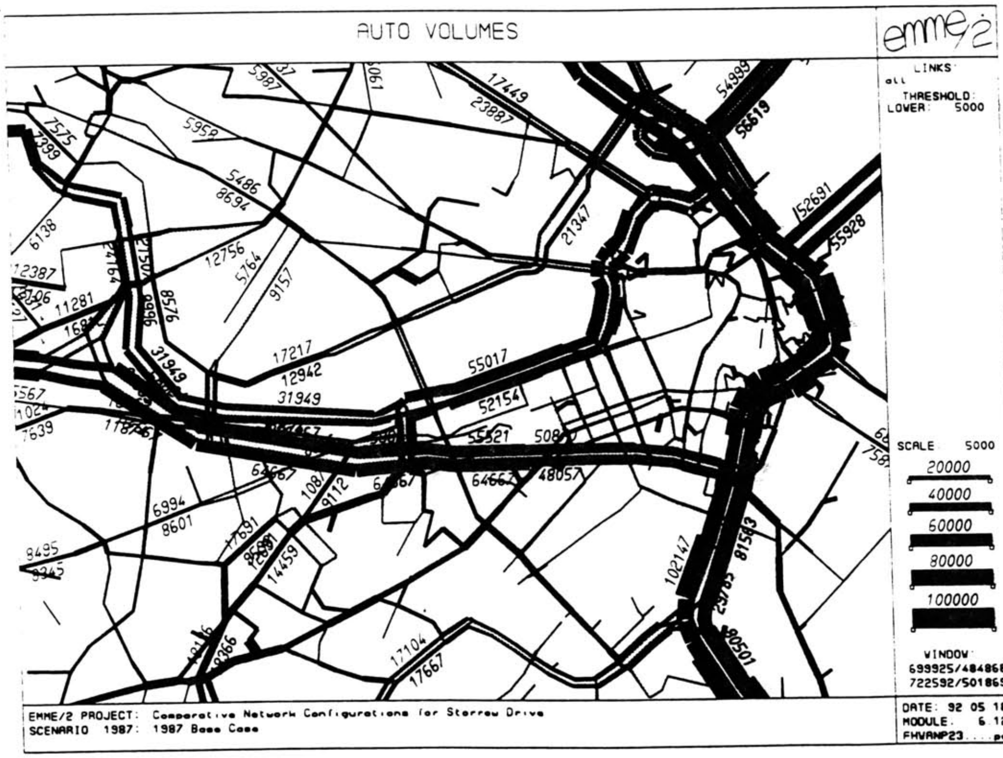


Figure 1.2-4. 1987 AWDT Volumes in Extended Core on Links With > 5,000 Vehicles.

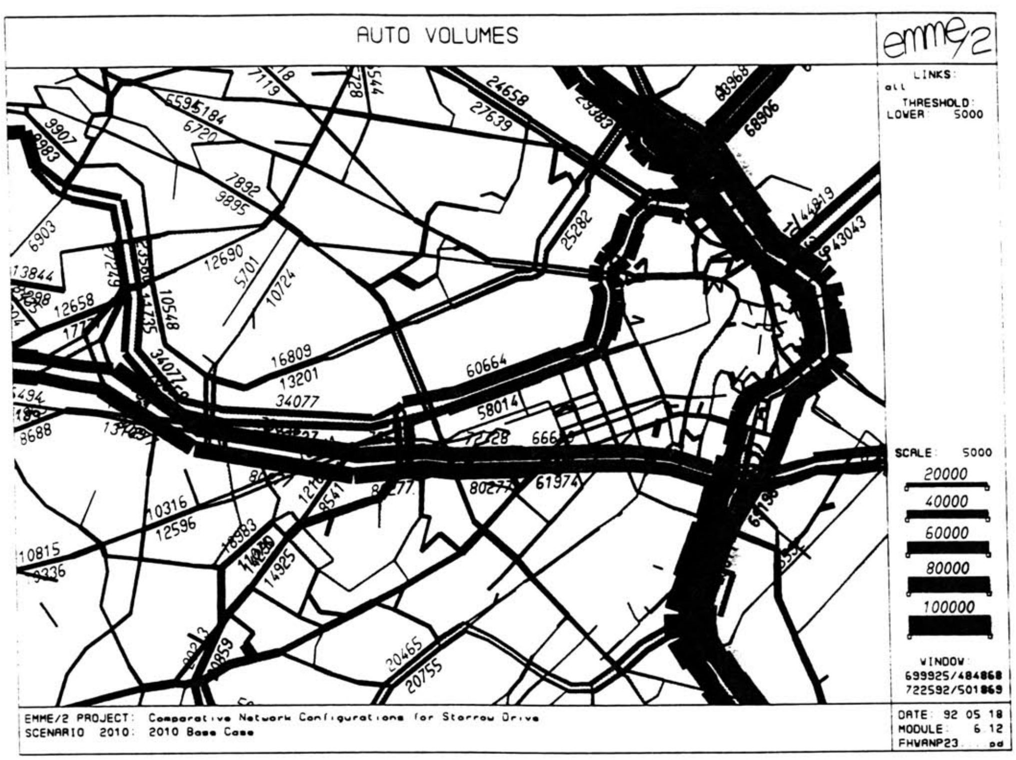


Figure 1.2-5. 2010 AWDT Volumes in Extended Core on Links With > 5,000 Vehicles.

A first set of traffic counts and assignment volumes are tabulated for intermediate spot locations in neighborhoods adjacent to the study area and Back Bay, such as Beacon Hill, the Kenmore Square area, Cambridge and Charlestown and shown in **Table 1.2-3a** and **Table 1.2-3b**. (Please note that all relevant data for the Back Bay can be found in the screenline summary of **Table 1.2-A1** for the Massachusetts Avenue, Berkeley and Newbury Street screenlines.)

		1	2	3	4	5
		1987	1987	(2-1)/1	2010	(4-2)/2
Location	**Link**	**Count**	**EMME/2**	**DIFF**	**EMME/2**	**DIFF**
Beacon Hill/West End/Gov Center						
Charles S of Mt.Vernon SB	2214-2233	7,500	9,525	21.3%	8,813	-8.1%
Beacon N of Walnut EB	2228-2227	14,500	7,810	-85.7%	7,575	-3.1%
Beacon N of Walnut WB	2227-2228	7,500	3,540	-111.9%	4,291	17.5%
Bowdoin N of Beacon NB	2225-2223	14,000	5,698	-145.7%	5,097	-11.8%
Cambridge W of Joy EB	2172-2173	20,000	17,883	-11.8%	14,855	-20.4%
Cambridge W of Joy WB	2173-2172	20,000	15,941	-25.5%	16,582	3.9%
New Sudb E of Camb EB	2175-2073	18,000	18,587	3.2%	18,493	-0.5%
New Chardon E of Camb WB	2074-2174	21,500	22,695	5.3%	17,872	-27.0%
Staniford S of Causeway NB	2082-2084	9,500	9,326	-1.9%	8,608	-8.3%
Staniford S of Causeway SB	2084-2082	8,000	6,107	-31.0%	14,280	57.2%
average increase						*-0.6%*
Kenmore Square/Fenway Area						
Comm Ave W of Essex St EB	5503-5512		18,330		19,154	4.3%
Comm Ave W of Essex St WB	5502-2568		25,143		26,048	3.5%
Comm Ave W of K. Square EB	5420-5426		6,726		7,934	15.2%
Comm Ave W of K. Square WB	5423-2697		12,689		13,840	8.3%
Comm Ave E of K. Square EB	5422-5611		18,317		21,619	15.3%
Comm Ave E of K. Square EB	5614-5423		14,631		18,530	21.0%
Beacon St W of K. Square EB	5609-5427		4,869		7,931	38.6%
Beacon St W of K. Square WB	5426-5608		8,336		13,141	36.6%
Brookline Ave S of K. Square NB	2705-5610		9,112		8,541	-6.7%
Brookline Ave S of K. Square SB	5610-2705		10,871		12,166	10.6%
Boylston E of Brookline EB	2705-3183		20,129		21,087	4.5%
Boylston E of Brookline WB	3183-2705		18,534		20,807	10.9%
Fenway S of Boylston NB	2694-3429		13,737		16,614	17.3%
Fenway S of Boylston SB	3429-2694		6,897		6,870	-0.4%
average increase						*12.1%*

Table 1.2-3a. Counts/AWDT Volumes in Beacon Hill/Kenmore Area (1987/2010).

Traffic in Beacon Hill changes little in volume between 1987 and 2010 but the routes of travel are affected by the new configuration of ramps from and to the Central Artery in downtown Boston and at Leverett Circle. In Charlestown, there are some major increases in volumes in the northbound direction while southbound volumes stay relatively stable. As was found in the subregional analysis, major traffic growth in Cambridge is concentrated on arterials such as the McGrath/O'Brien Highway, Cambridge Street and Memorial Drive in the West. Finally, in the Kenmore Square/Fenway area most volume increases occur on Commonwealth Avenue and Beacon Street.

Location	Link	1 1987 Count	2 1987 EMME/2	3 (2-1)/1 DIFF	4 2010 EMME/2	5 (4-2)/2 DIFF
Charlestown Locations						
Sullivan Sq overpass NB	3459-3461	9,000	9,868	8.8%	11,933	17.3%
Sullivan Sq overpass SB	3462-3460	14,000	10,274	-36.3%	14,606	29.7%
Rutherford N of Austin NB	3321-3322	20,000	17,388	-15.0%	31,161	44.2%
Rutherford N of Austin SB	3394-3327	30,000	30,301	1.0%	32,330	6.3%
Rutherford N of City Sq NB	3316-3317		19,860		32,959	39.7%
Rutherford N of City Sq SB	3330-3315		29,323		29,001	-1.1%
Prison Point Bridge EB	3393-3338	14,000	29,703	52.9%	29,374	-1.1%
Prison Point Bridge WB	3340-3390	13,500	32,988	59.1%	29,555	-11.6%
average increase						*14.8%*
Cambridge Locations						
Mem W of Longfellow EB	4380-3635	23,000	21,239	-8.3%	25,525	16.8%
Mem W of Longfellow WB	3636-4379	17,500	17,925	2.4%	20,044	10.6%
Mem S of River St Bridge EB	4418-4419		9,996		11,735	14.8%
Mem S of River St Bridge WB	4419-4418		8,576		10,548	18.7%
Mass Ave N of Main St NB	4484-4481		13,451		15,112	11.0%
Mass Ave N of Main St SB	4481-4484		17,179		18,861	8.9%
Cambridge W of O'Brien EB	3472-3470	23,000	14,695	-56.5%	20,620	28.7%
Cambridge W of O'Brien WB	3470-3472	15,500	11,049	-40.3%	14,688	24.8%
Cambridge W of 1st EB	3473-3472	7,000	7,929	11.7%	7,596	-4.4%
Cambridge W of 1st WB	3472-3473	6,500	8,389	22.5%	10,056	16.6%
O'Brien N of Cambridge NB	3469-3540	18,000	13,129	-37.1%	20,195	35.0%
O'Brien N of Cambridge SB	3541-3470	20,500	18,496	-10.8%	24,553	24.7%
McGrath N of SV Ave NB	5258-5245	20,000	13,613	-46.9%	19,185	29.0%
McGrath N of SV Ave SB	5246-5259	23,000	14,487	-58.8%	16,211	10.6%
Main W of Longfellow EB	3637-3632	14,000	14,577	4.0%	16,262	10.4%
Main W of Longfellow WB	3631-3638	16,500	17,098	3.5%	17,573	2.7%
average increase						*17.5%*

Table 1.2-3b. Counts/AWDT Volumes in Cambridge and Charlestown (1987/2010).

Again, it should be pointed out that the projected increases are very large considering current levels of traffic on most of these roadways. The growth in VMT and traffic volumes on most arterials seems to exceed actual carrying capacities of these roadways. The frequency and duration of congestion which can already be witnessed today would be considerably increased under the trip growth assuptions underlying the year 2010 forecasts.

Traffic volumes on key corridors such as the Central Artery or facilities running parallel to Soldiers Field Road/Storrow Drive, such as the Massachusetts Turnpike Extension — Memorial Drive volumes were reported in **Table 1.2-3b** — area reported in **Table 1.2-4a** and **Table 1.2-4b**. Where available, DPW counts and assignment volumes from the CTPS Regional Model are also included. Similarly to the previous table, differences between counts and assigned volumes as well as increases between 1987 and 2010 are calculated.

		1	2	3	4	5	6	
	1987 Link	1987 Count	CTPS 1987 Base	EMME/2 1987 Base	(3-1)/1 DIFF	EMME/2 2010 Base	(5-3)/3 DIFF	2010 Link
Central Artery								
Central Artery N of Mass Ave								
Northbound	2526-2558	67,000	83,777	81,563	21.7%	123,793	51.8%	2555-2556
Central Artery S of Albany St								
Southbound	2522-2523	100,500	101,104	102,147	1.6%	128,513	25.8%	6124-6125
Total		167,500	184,881	183,710	9.7%	252,306	37.3%	
Artery N of Northern Ave on-ramp								
Northbound	1854-1855	99,000	93,961	93,969	-5.1%	107,309	14.2%	6282-6147
Artery S of Haymarket on-ramp								
Southbound	2044-1860	90,000	88,661	88,227	-2.0%	124,140	40.7%	6160-6161
Total		189,000	182,622	182,196	-3.6%	231,449	27.0%	
Artery @ Mass Turnpike								
Northbound	2530-2531	74,000	80,611	82,002	10.8%	85,680	4.5%	
Southbound	2517-2518	87,000	82,380	83,317	-4.2%	92,699	11.3%	
Total		161,000	162,991	165,319	2.7%	178,379	7.9%	
Central Artery S of Causeway								
Northbound	2039-2040	99,000	95,188	94,754	-4.3%	133,561	41.0%	6151-6152
Southbound	2041-2042	92,000	91,660	90,417	-1.7%	140,087	54.9%	6157-6206
Total		191,000	186,848	185,171	-3.1%	273,648	47.8%	
Artery Bridge								
Northbound	2113-1834	92,000	86,518	88,823	-3.5%	133,561	50.4%	6152-6153
Southbound	1833-2116	87,000	92,627	90,342	3.8%	140,087	55.1%	6156-6157
Total		179,000	179,145	179,165	0.1%	273,648	52.7%	

Table 1.2-4a. Counts/AWDT Volumes on the Central Artery (1987/2010).

As expected, volume increases on the Central Artery are the largest in this group due to the complete reconstruction and widening of the highway, ranging from less than 38% south of Albany Street in Boston to more than 52% on the Artery Bridge. At the time the network was coded, Scheme Z was still the proposed action although a committee has since been in the process of developing an alternative interchange design. Therefore, the interchange and configuration of year 2010 Leverett Circle all reflect the Scheme Z design. The "Leverett Connector Bridge," as the parallel bridge to the mainline leading to Leverett Circle and North Station will be referred to in this paper, is estimated to carry 150,000 vehicles daily over the Charles River in addition to the more than a quarter million trips on the Artery Bridge. Because of the double crossing of the river to move between the Leverett/North Station area and the Central Artery in Boston, these volumes are not strictly comparable for the two analysis years.

Although the Massachusetts Turnpike is a facility whose total capacity is comparable to that of the Central Artery before reconstruction, it can be seen that the volumes it carries in 1987 are only between one-half and two-thirds of the latter. Although the utilization of the Mass Turnpike Extension increases through the expansion of Central Artery capacity, the better connection at the I-90/I-93 interchange, as well as the addition of the Third Harbor Tunnel, by 2010, the gap between volumes it carries and those on the Central Artery itself becomes larger. In addition to the increase in Central Artery capacity, this could be attributable to the fact that there is no large parallel arterial or expressway to the Central Artery which could be used as an alternative route while the Turnpike is complemented by Storrow and Memorial Drive which accomodate significant amounts of East-West travel.

		1	2	3	4	5	6	
			CTPS	EMME/2		EMME/2		
	1987	1987	1987	1987	(3-1)/1	2010	(5-3)/3	2010
	Link	Count	Base	Base	DIFF	Base	DIFF	Link
Turnpike Eastbound								
TP W of Beacon Park	5477-5478	57,500		62,014	7.9%	74,845	20.7%	
Beacon Park off	5478-1664	17,500		14,381	-17.8%	13,681	-4.9%	
Beacon Park on	1651-5484	15,000		17,034	13.6%	19,114	12.2%	
TP E of Beacon Park	5484-5485	55,000	59,813	64,667	17.6%	80,277	24.1%	
Copley off	2411-2297	13,000		16,609	27.8%	18,303	10.2%	
TP W of CA	2414-2415	42,000	44,565	48,057	14.4%	61,974	29.0%	2414-6333
TP E of CA	6141-6430	n/a	n/a	n/a		37,563		
Turnpike Westbound								
TP E of CA	6604-6429	n/a	n/a	n/a		50,802		
TP W of CA	2405-2406	40,000	39,984	43,608	9.0%	61,413	40.8%	
Arlington on	5600-2406	4,500		4,837	7.5%	4,250	-12.1%	
TP W of Arl on	2406-2407	44,500	44,629	48,444	8.9%	65,663	35.5%	
Clarendon on	2350-2407	1,000		2,426	142.6%	1,017	-58.1%	
TP W of Clar on	2407-2408	45,500		50,870	11.8%	66,680	31.1%	
Copley Sq on	2296-2408	5,500		4,651	-15.4%	6,047	30.0%	
TP W of Copley	2408-2409	51,000	52,069	55,521	8.9%	72,728	31.0%	
Mass Ave on	3236-3424	3,000		3,304	10.1%	3,931	19.0%	
TP E of Beacon Park	5486-5483	54,000		58,824	8.9%	76,658	30.3%	
Beacon Park off	5483-1658	15,000		15,351	2.3%	17,589	14.6%	
Beacon Park on	1667-5479	17,000		12,842	-24.5%	11,472	-10.7%	
TP W of Beacon Park	5479-5476	56,000		55,955	-0.1%	70,542	26.1%	

Table 1.2-4b. Counts/AWDT Volumes on the Massachusetts Turnpike (1987/2010).

Memorial Drive in Cambridge is an arterial which is signal-controlled in its Western portion between Eliot Bridge and River Street Bridge and almost uncontrolled to the East until the intersection at the Msgr. O'Brien Highway. The traffic volumes it carries reflects the two different characters of the roadway with about 15,000 vehicles using the facility in the East and about 40,000 vehicles in the vicinity of Longfellow Bridge.

1.2.5. Study Area

Storrow Drive/Soldiers Field Road serves as a regional highway link between Route 1, 1A and I-93 from the Northeast, Route 2 from the Northwest, I-90 to the West, and the Worcester Turnpike/Fenway from the Southwest. The study area is bounded by Charlesgate on the West and Leverett Circle on the East. While the Turnpike is designed as a modern eight-lane freeway and Storrow Drive as a six-lane hybrid of a conceived parkway and a realized highway, both carry comparable volumes of traffic. This is the case because in addition to its regional function, Storrow Drive serves as a local distributor for the Back Bay, Beacon Hill and Government Center while the Turnpike cannot serve the same distribution function in the absence of effectively located ramps. **Table 1.2-5** lists auto volumes along Soldiers Field Road south of the Western Avenue Bridge and of Storrow Drive along with those at ramp locations for the years 1987 and 2010. Almost all access and egress movements in the study area occur either at a) Charlesgate, b) the Back Bay ramps, an area between Clarendon Street and Pinckney Street at the border of Beacon Hill and the Back Bay which will be referred to as the Arlington/Berkeley Ramp Area in this report, or c) Charles Circle. In the following, traffic movements at these locations are described in more detail.

Charles Circle is an important node linking an arterial connection between Cambridge and Boston with the regional highway network via Storrow Drive. According to the model traffic assignments, in 1987 (2010) almost 30,000 (28,500) vehicles enter Charles Circle from Storrow Drive while about 17,500 (22,200) vehicles use Charles Circle as access to the Storrow expressway. Adding the approximate 30,000 (35,000)

		1	2	3	4	5	
	1987 Link	1987 Count	1987 Base	(2-1)/1 DIFF	2010 Base	(4-2)/2 DIFF	2010 Link
Soldiers Field Road/Storrow Drive Eastbound							
SF Road N of Western	5415-5416		30,770		35,154	14.2%	
Western Ave off	5416-3113		6,606		7,906	19.7%	
SF Road S of Western	5416-5417		24,164		27,249	12.8%	
River St on	3111-5417		8,719		8,946	2.6%	
BU off	1820-5495		5,424		5,925	9.2%	
BU on	5495-1820		6,808		7,267	6.7%	
SD W of Fenway	1820-3456		34,267		37,537	9.5%	
Charlesgate off	3456-3452		2,644		2,308	-12.7%	7014-3449
Fenway off	3453-3451		10,161		10,855	6.8%	3456-7021
Total off			12,805		13,163	2.8%	
SD @ Muddy River	3413-3404	29,000	22,526	-22.3%	24,373	8.2%	7014-7011
Fenway on	3434-3414		19,102		22,510	17.8%	
Charlesgate on	3415-3414		10,526		11,131	5.7%	3415-7011
Total on	3414-3404	24,500	29,628	20.9%	33,641	13.5%	
SD E of Mass	3404-2464	53,500	53,225	-0.5%	58,014	9.0%	3404-7000
Dartmouth off	2464-2465	2,000	1,721	-14.0%	1,622	-5.8%	
Clarendon off	2464-2459	3,500	3,087	-11.8%	3,140	1.7%	
Arlington off	2311-2309	7,500	4,221	-43.7%	4,039	-4.3%	
Berkeley on	2306-2291	13,000	16,217	24.7%	18,692	15.3%	2368-2311
Embankment on	2212-2211	9,000	5,654	-37.2%	8,578	51.7%	
Total Back Bay off		13,000	9,029	-30.5%	8,801	-2.5%	
Total Back Bay on		22,000	21,871	-0.6%	27,270	24.7%	
SD @ Revere	2209-2190	62,500	67,799	8.5%	79,932	17.9%	
CC off-ramp	2190-2184	17,500	20,761	18.6%	15,895	-23.4%	
SD E of CC off	2190-2188	45,000	44,202	-1.8%	61,848	39.9%	
Charles/Blossom on	2145-2103	14,000	3,077	-78.0%	8,913	189.7%	2145-6485
SD W of Leverett (surface)	2103-2104	59,000	47,279	-19.9%	21,204	-55.2%	6485-6254
SD W of Leverett (tunnel)			n/a		49,557		6483-6495
ramps to I-93	2105-2106		41,883		73,685	75.9%	6248-6249
Storrow Drive/Soldiers Field Road Westbound							6245-2126
ramps from I-93	2120-2121		48,890		74,846	53.1%	6242-6243
Leverett off	2121-2093		14,269		21,253	48.9%	6243-6247
Leverett on	2125-2126		27,805		16,456	-40.8%	6253-2126
SD W of Leverett	2126-2146	62,000	62,426	0.7%	70,050	12.2%	
CC off	2146-2155	12,500	9,265	-25.9%	12,424	34.1%	2126-2155
SD W of CC off	2146-2147	49,500	53,161	7.4%	57,626	8.4%	2146-2188
CC on	2148-2159	11,000	14,484	31.7%	13,425	-7.3%	7004-2189
SD @ Revere St	2189-2210	60,500	67,645	11.8%	71,051	5.0%	
Arlington off	2295-2309	17,000	22,027	29.6%	21,224	-3.6%	
Berkeley St on	2368-2460	9,500	9,399	-1.1%	10,857	15.5%	2368-2463
Total Back Bay off			22,027		21,224	-3.6%	
Total Back Bay on			9,399		10,857	15.5%	
SD E of Mass Ave	2463-3065	53,000	55,017	3.8%	60,664	10.3%	
Mass Ave off	3405-3406	2,000	336	-83.2%	2,531	653.3%	
SD W of Mass Ave off	3405-3437	51,000	54,680	7.2%	58,134	6.3%	3405-7010
Fenway off	3440-3442		18,864		20,312	7.7%	7010-7013
Charlesgate off	3440-3450		18,559		19,899	7.2%	7012-3415
Total off	3437-3440		37,423		40,211	7.4%	
SD @ Muddy	3437-3454		17,258		17,923	3.9%	7012-7015
Charlesgate on	3436-3438		3,111		4,565	46.7%	3449-7015
Fenway on	3435-3438		11,581		11,589	0.1%	7020-3455
Total on	3438-3455		14,692		16,154	10.0%	
SD W of Fenway	3455-1821		31,949		34,077	6.7%	
River St off-ramp	1824-3112		10,442		10,517	0.7%	
SF Road S of Western	1824-1825		21,507		23,560	9.5%	
Western Ave on-ramp	3114-1825		8,456		9,250	9.4%	
SF Road N of Western	1825-1826		29,963		32,810	9.5%	

Table 1.2-5. Counts/AWDT Volumes on Storrow Drive/Soldiers Field Road (1987/2010).

vehicles which pass over the Longfellow Bridge and Cambridge Street implies that the Charles Circle quasi-rotary is crossed by close to 70,000 (75,000) cars every working day, making it one of the highest-volume intersections in the city. **Figure 1.2-6** and **Figure 1.2-7** depict the links and their respective traffic volumes in and around Charles Circle. In reference to the previous table, however, it should be kept in mind that in this location the assignment and traffic counts diverge sometimes significantly.

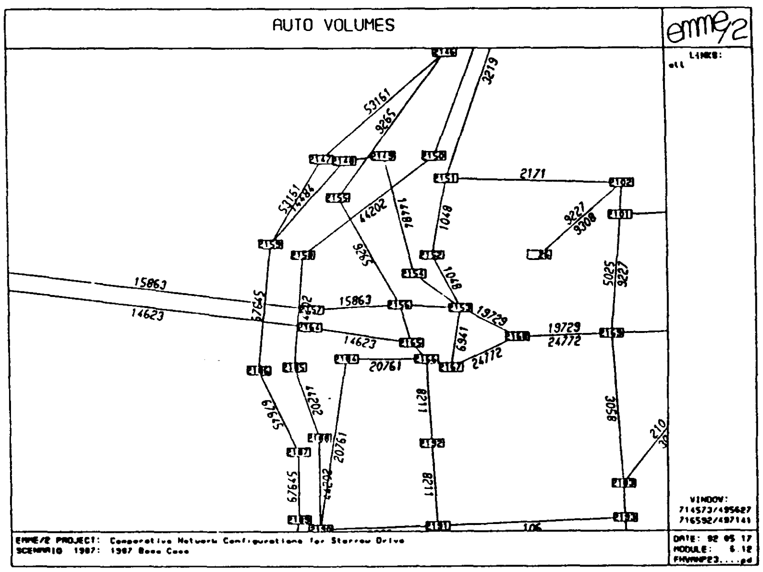


Figure 1.2-6. 1987 AWDT Volumes on Links at Charles Circle.

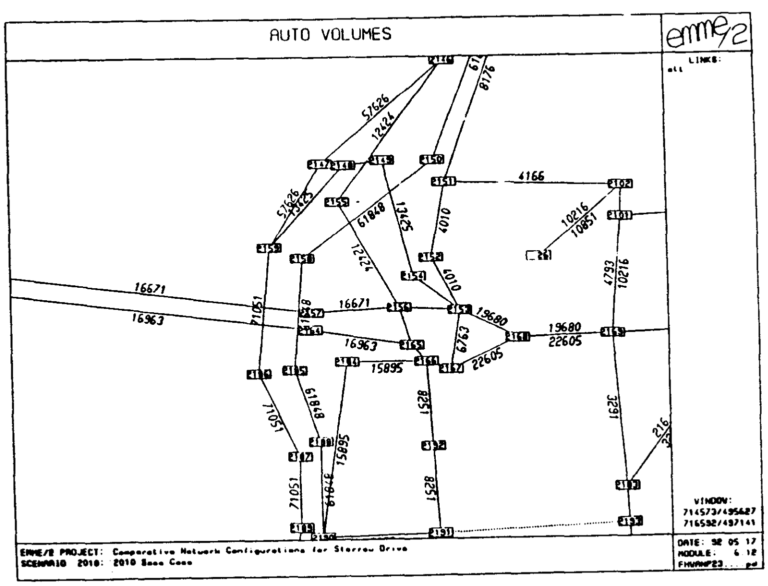


Figure 1.2-7. 2010 AWDT Volumes on Links at Charles Circle.

The Arlington/Berkeley Ramp Area serves as the primary connection to the Back Bay and some downtown locations from and to Storrow Drive. In absence of access ramps to the Turnpike in eastbound direction, most vehicles with destinations in the North or East, such as Logan airport, use Storrow Drive as the regional connection. For vehicles traveling eastbound on Storrow Drive, the Clarendon and Arlington Street exits are used to access the Back Bay east of Charlesgate while for westbound vehicles the Back Bay connection is provided through an off-ramp at the Arlington Street. Vehicles approaching Storrow Drive in this area either come from the Back Bay and points South using Berkeley Street or from downtown locations using Beacon Street and Embankment Road. In 1987 (2010), according to the model, a total of 31,500 (38,000) vehicles use these ramps for access and 31,000 (30,500) for egress. These volumes, which are even greater than those for Charles Circle, are shown in **Figure 1.2-8** and **Figure 1.2-9**.

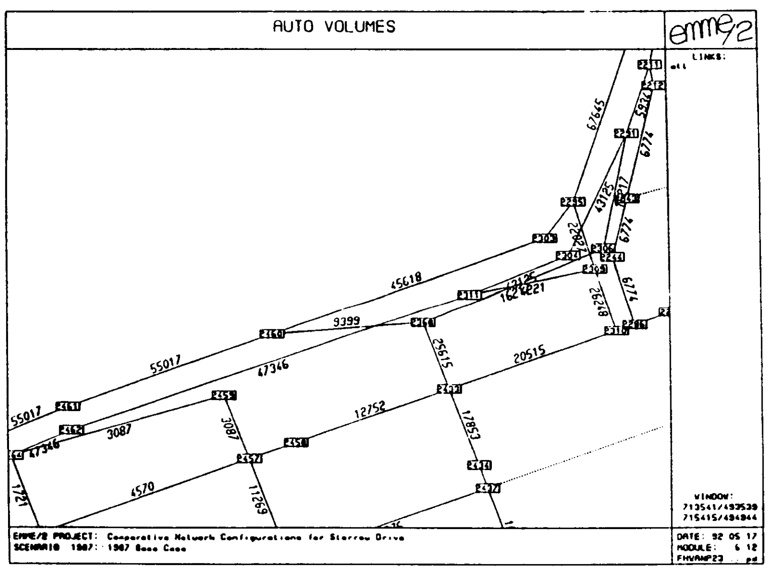


Figure 1.2-8. 1987 AWDT Volumes on Links in the Arlington/Berkeley Ramp Area.

At Charlesgate, vehicles traveling on arterials from the West and Southwest can access Storrow Drive via the Bowker overpass. The overpass connects the Fenway with the Kenmore Square area and the expressway on the lower bank of the Charles River. As can be seen in **Figure 1.2-10** and **Figure 1.2-11**, 68,000 (76,000) vehicles use the overpass of which 60,500 (62,500) travel between Soldiers Field Road/Storrow Drive and

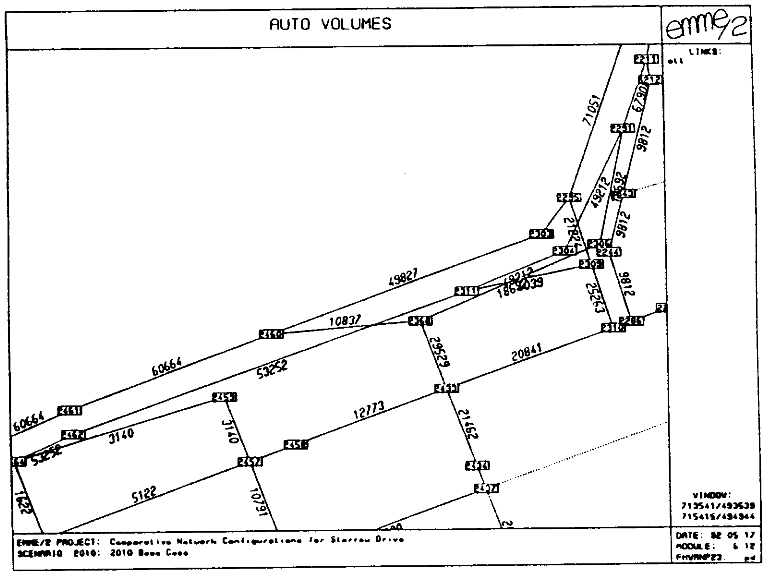


Figure 1.2-9. 2010 AWDT Volumes on Links in Arlington/Berkeley Ramp Area.

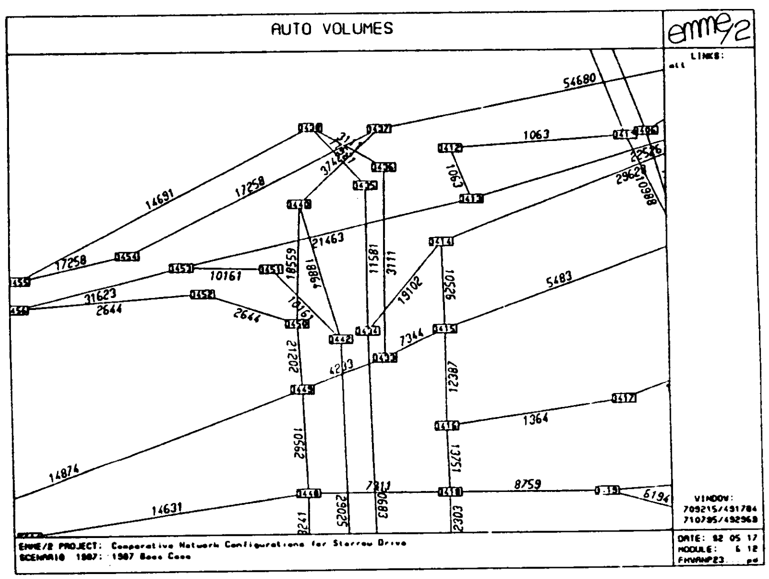


Figure 1.2-10. 1987 AWDT Volumes on Links at Charlesgate.

the Fenway in 1987 and 2010, respectively. Again, in the absence of any direct connection to the regional highway system via the Turnpike, vehicles use Storrow Drive to reach points in the Northeast. The percentage of Storrow Drive vehicles from the East which do not exit at Charlesgate is only 32% of the volumes at the Massachusetts Avenue screenline. Similarly, Storrow Drive through vehicles eastbound account for less than

45% of the total volume at the same screenline. This shows that the majority of vehicles using Storrow Drive to the East of Charlesgate have their origins/destinations in the Southwest, not in the Northwest.

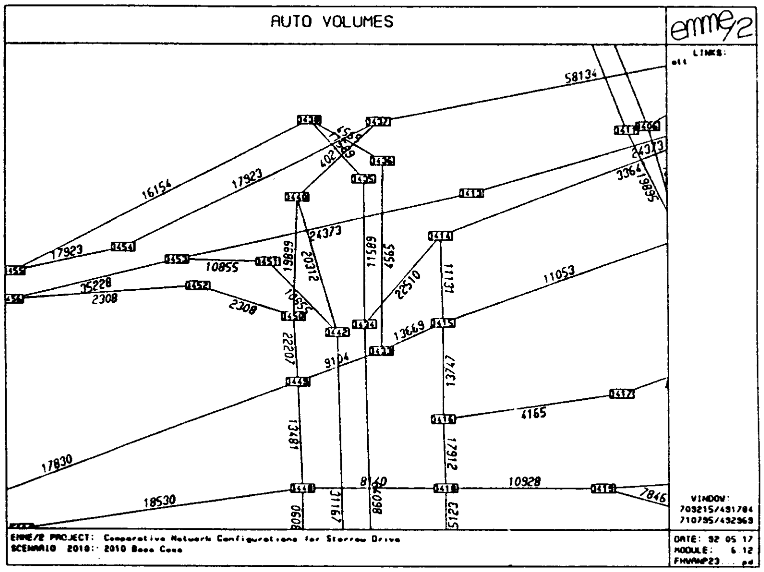


Figure 1.2-11. 2010 AWDT Volumes on Links at Charlesgate.

1.2.6. Select Link Analysis

In order to elaborate on the observations made above, a tool called select link analysis is applied to deliver some more information on who the users of a particular facility are. This technique, which is a standard feature of conventional CTM packages, such as the software used for the analysis of this paper, EMME/2, allows the analyst to determine origins and destinations of trips which pass through specified links of the network. **Figure 1.2-12** provides a regional view of Storrow Drive users in 1987. In this graphic, where links with volumes below 5,000 vehicles in one direction are suppressed, we can see that from the North, I-93 and Route 1 are the primary feeder paths, while Logan airport appears to be a major origin/destination in the East. High volumes on Route 2 in the Northwest, Route 20 (Arsenal Street) in the West and the arterials bordering the Emerald Necklace in the Southwest indicate that many trips originate or end in their vicinity. From the Southeast there appears to be no similarly important access corridor. This is plausible since Storrow Drive is not part of most traveling paths which lead to and from locations in the Southeast. Rather, these areas are served by the Southeast Expressway and arterials in the South, such as Blue Hill Avenue and Massachusetts Avenue.

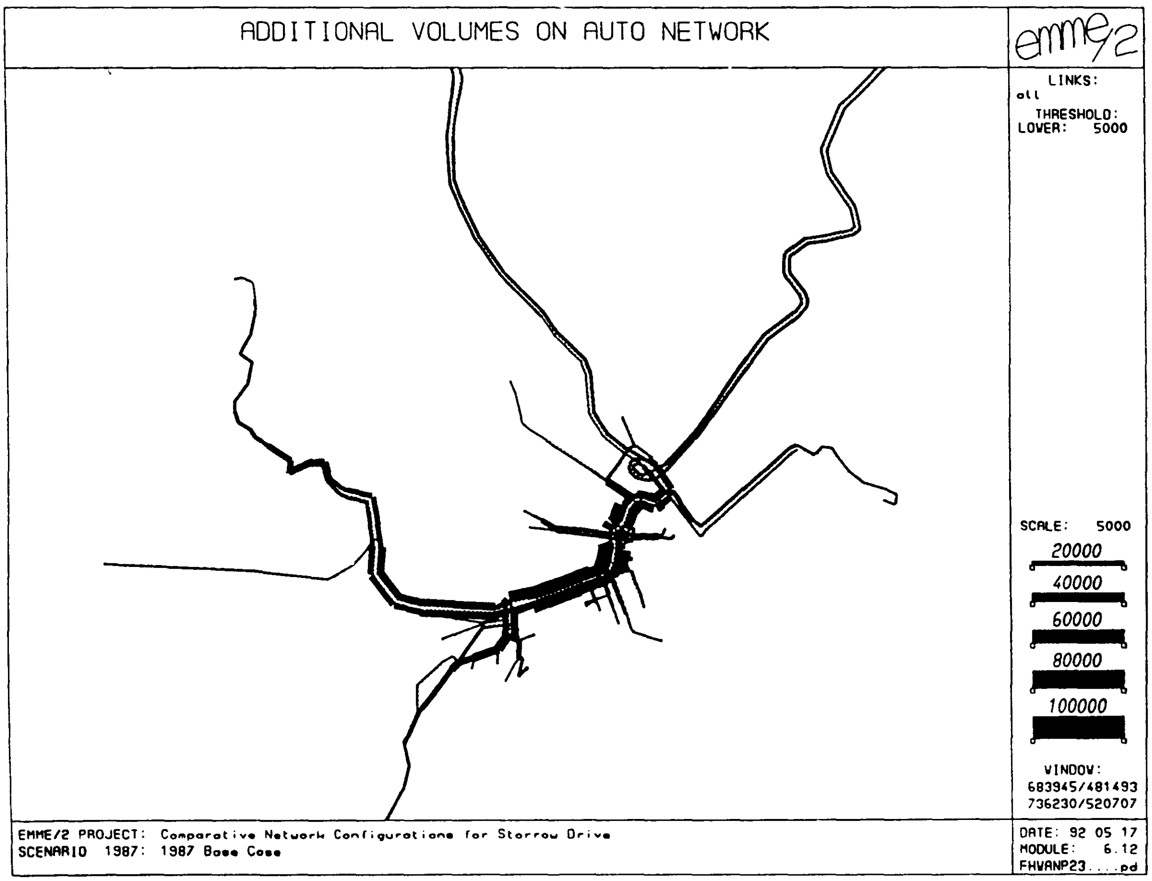


Figure 1.2-12. 1987 Origins and Destinations of Storrow Drive Users - Subregion.

Taking a closer look at roads in the vicinity of the study area, one can see that many trip ends are located in the Back Bay, Beacon Hill, Government Center and the North Station area. **Figure 1.2-13**, which shows traffic volumes on links which carry over 2,500 *Storrow* vehicles daily in each direction, indicates that streets crossing the Back Bay, such as Arlington, Berkeley, Clarendon and Dartmouth Street are frequently used to reach the commercial areas at the southern periphery of the Back Bay in 1987. Some analysis done by CTPS in 1990 examining trip origins and destinations of vehicles using the I-93 ramps at Leverett Circle indicates that almost 70% of all trips using the ramp to access I-93 originate in areas *outside* of the districts close to downtown.[50] Of those vehicles entering Storrow Drive from I-93, less than 50% are destined for these central areas. This underlines the importance of Storrow Drive as a regional connector between the I-93/Tobin expressway system and points to the West and Southwest.

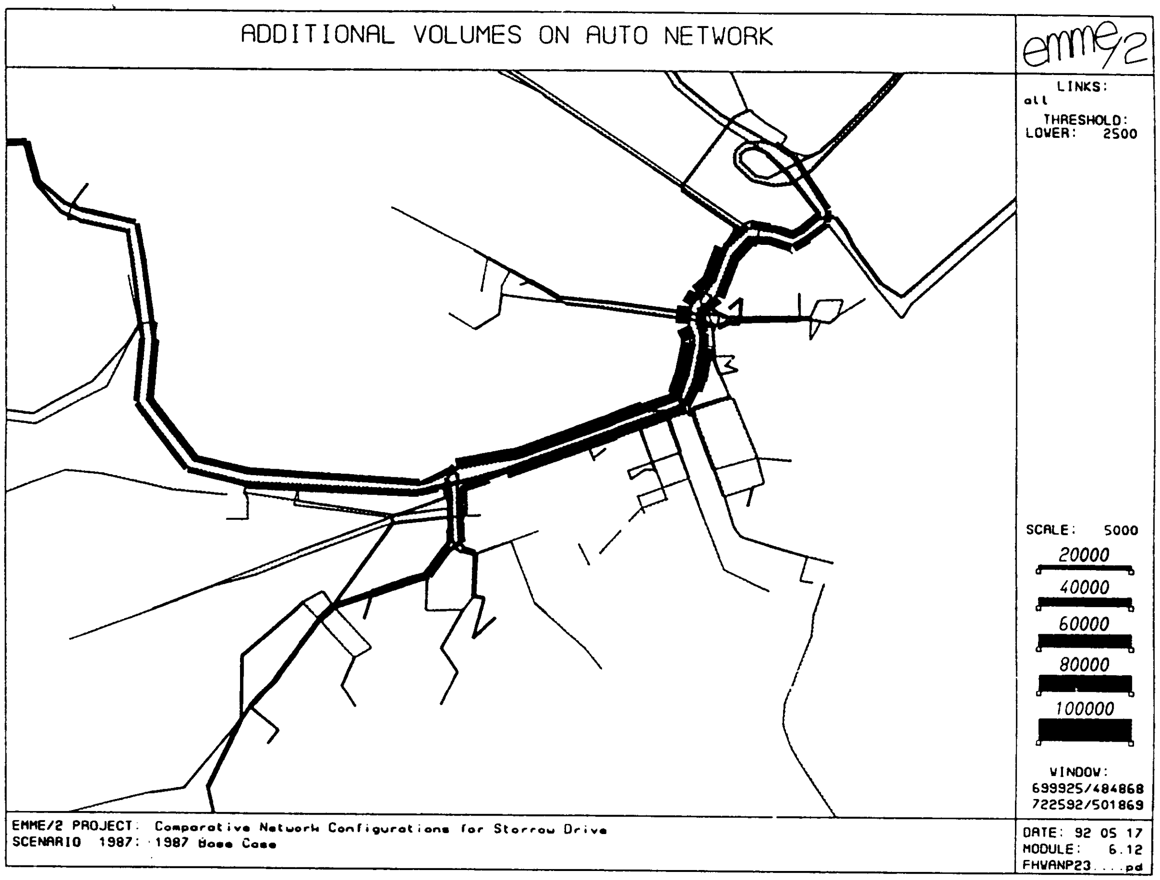


Figure 1.2-13. 1987 Origins and Destinations of Storrow Drive Users - Extended Core.

The preceeding section has provided an overview of vehicular travel in the subregion, extended core and study area for the years 1987 and 2010. The subregion-wide increase in total vehicular trips is expected to be almost 20% over this 23-year period. While the completion of the Central Artery/Third Harbor Tunnel project leads to some redistribution of traffic volumes in the network there appears to be no major individual beneficiary of trip diversions occuring as a consequence of the central bottleneck elimination. Storrow Drive, performing multiple transportation roles as a regional highway link and local distributor, will experience volume increases comparable to those in the remainder of the traffic network. This implies that a potential benefit of greater Central Artery capacity, and a Logan airport access path different from the current one using Storrow Drive, is more than offset by the system-wide increases in overall vehicular travel.

The projected growth in traffic are likely to substantially increase congestion in large parts of the road network. The assumptions underlying the travel demand estimates for the year 2010 do not reflect an agreement reached between the Conservation Law Foundation (CLF) and the State which stipulated that there be no increases in radial capacity and the enforcement of a parking freeze as part of the Central Artery project. The estimated year 2010 volumes from the model vividly illustrate the consequences of uncontrolled growth in vehicle travel and underscore the need to respond to future mobility needs with appropriate policies, as will be discussed in Part III.

Chapter 2
Transportation As Barrier
Pedestrian Accessibility and Open Space

While Storrow Drive currently serves an important linkage function in the network, it constitutes a barrier to accessing the river and adjacent park from the Beacon Hill and Back Bay communities. It is a roadway which was designed to move vehicles swiftly and the abutting environment reflects this hierarchy in planning. Pedestrians resort to sporadic bridge connections to reach the Esplanade whose value as a vital open space in the dense urbanized core suffers from the immediate proximity of this high-speed facility. Thus, the cost in quality of life to the urban dweller afforded by the manner in which Storrow Drive cuts between the Esplanade and neighborhoods sharply contrasts its benefit to the urban motorist.

This chapter elaborates on these problems by examining at which locations and in which form they are most evident. The three specific focal locations selected for analysis are Charles Circle, the Arlington/Berkeley Ramp Area and Charlesgate which, in addition to being key transportation nodes in the study area, are preeminent examples of where access to the Esplanade is particularly exacerbated by the expressway.

2.1. Charles Circle

Charles Circle lies at the northwestern periphery of Beacon Hill. Its vicinity to the Esplanade, Massachusetts General Hospital, the West End and Beacon Hill make it an important node of activity and movement in the city. The following describes some of Charles Circle's key features as a piece in Boston's urban environment.

2.1.1. Transportation

The West Boston Bridge was one of the first bridges connecting Boston and Cambridge. Constructed in 1793, it was replaced by a new structure half a century later and by the current Longfellow Bridge in 1906.[51] With the completion of Embankment Road in 1910 on filled land and the widening of Cambridge Street in 1924, what is Charles Circle today developed into an important node in the road network. As one of the key automobile access corridors into Boston, Cambridge Street began to change its character from a local city street to an important vehicular link, establishing services along its sides catering to the automobile, such as gas stations and repair shops.[52]

When in 1912 the MBTA Red Line was extended to Harvard Square, an elevated structure between Grove Street and the Longfellow Bridge was built. In the process, 22 structures on Cambridge Street and Lindall Place were demolished, leaving empty lots most of which have remained so until today. Because of high demand by residents and the growing Massachusetts General Hospital (MGH) to gain access to the subway system, the Charles Street Station was constructed around the elevated structure in the middle of the traffic circle in 1932. This necessitated the widening of the intersection — and demolition of buildings along Cambridge Street — and resulted in the kind of rotary design from which Charles *Circle* derives its name.[53] Today, the Red Line station is widely used, especially by employees of the Massachusetts General Hospital, West End and Beacon Hill residents, and users of the closely located Esplanade.

In 1951, North Charles Street and Embankment Road were integrated into the new Storrow Drive expressway which established a direct connection between Leverett Circle in the North and Allston in the West.[54] In order to accommodate the increased volumes of traffic, two viaducts connecting the westbound Storrow Drive with Charles Circle were constructed. Charles Circle, apart from Leverett Circle,[55] is the only interchange along the length of Storrow Drive which allows all movements between expressway eastbound and westbound traffic, Cambridge and downtown Boston. The intersection is heavily utilized with typical[56] turning volumes between 10,000 and 15,000 vehicles on an average weekday. Peak hour turning movements and major origins and destination in the vicinity of Charles Circle area shown in **Figure 2.1-A1** (in the appendix). In 1987, intersection level-of-service (LOS) was in the range of C and D on the north side and F on the south side of the transit station, as depicted in **Figure 2.1-A2** (in the appendix).[57]

Charles Circle, shown in **Figure 2.1-1**, has a complex and confusing intersection design in spite of the fact that pedestrian traffic has been virtually removed from the surface. The quasi-rotary layout, necessitated by the overhead Red Line Station, multiple parallel turning possibilities, ambiguous signal controls and a popular stopping point at the southern periphery, Philips Drugstore, all contribute to a high degree of disorientation and unpredictable driving behavior within the vast asphalt arena. Furhtermore, the Eye and Ear Infirmary parking lot, nested between the loops of the connector ramps to and from Storrow Drive westbound, infuses traffic into the traffic circle at a difficult angle which has prompted proposals in the past to close it.[58] Although I have not seen accident statistics, the frequency of angry honking is a reasonable proxy for the number of misunderstandings occurring between motorists in Charles Circle.[59] The layout of Charles Circle is both space-consuming and confusing to pedestrians and motorists alike.

Figure 2.1-1. Aerial View of Charles Circle.

2.1.2. Open Space

When in 1891 Charlesbank Park was constructed on filled land, it was the first park to be completed in the park system. Until the erection of ramps to connect the northern Charles Street with Cambridge Street which led to the closure of Charlesbank Park, it was one of the major outdoor recreational facilities in Boston, serving residents from the West End, Beacon Hill and beyond.[60] Today, Charlesbank Park is merely an abstracted piece of parkland squeezed between the always-congested Leverett Circle and the mainline high-speed Storrow Drive segments which almost reach the river bank west of Charles Circle. Since there are few crossing possibilities and the high-speed Storrow Drive intrudes far into park, employees and visitors of MGH and residents of Charles River Park hardly use this piece of open space.

The embankments on both sides of the river were developed as parkland during and after damming of the Charles River in 1910 and twenty years later the Esplanade south and west of the Longfellow Bridge was completed. The banks of the Charles River and the Esplanade are recognized as one of Boston's greatest open space resources. However, with the construction of Storrow Drive and the Charles Circle interchange between 1949 and 1951, an important piece of the River Esplanade was destroyed, cutting off the park north of the Longfellow Bridge and effectively separating the parkland and river from the rest of the city.

What used to be open parkland, today are two grey parking lots owned by the Massachusetts Eye and Ear Infirmary which are nested between the loops of the highway connectors. An area of approximately 10 acres is devoured by parking lots, viaducts, roadways or inaccessible and "unusable" space. Charles Circle itself has been described as a "disorienting and complex traffic network spliced together with fragments of underutilized parkland."[61] The reduction of open space caused by the construction of the expressway forty years ago has been substantial and parkland added to replace this loss is far less accessible for the people in the West End. The resulting loss of contiguity between and direct access to open spaces has maybe had an even more severe negative open space impact because it fragmented the park into more isolated and less accessible pieces. This is further reinforced by the lack of physical and pedestrian connections, as is discussed below.

2.1.3. Pedestrian Circulation

The alignment of Storrow Drive and the interchange at Cambridge Street, as well as the placement of the transit station on a traffic island in the center of Charles Circle, severely curtail pedestrian movements in this area and make walking less enjoyable and safe. Some of the key determinants of the quality of the pedestrian environment in this area are depicted in **Figure 2.1-A3** in the appendix.

First, the existing roadway configuration has virtually cut off the Esplanade section northeast of the Longfellow Bridge. As was mentioned above, this primarily deprives residents from the West End of an important open space asset. In the 1960s, people in this area suffered from an urban renewal scheme which further deteriorated the quality of their immediate environment. The narrowing of the park to a strip only about 40 feet wide at the interchange's widest point — under the Longfellow Bridge — make it more difficult to establish a psychological connection from the main southwestern portion of the Esplanade. In addition, pedestrians entering Boston from the northern sidewalk of the Longfellow Bridge have no direct connection to the Esplanade. To reach the river, the Longfellow Bridge must be passed under twice through dark and unpleasant underpasses. Similarly, on the southern side of the bridge sidewalks are much too narrow to walk comfortably and both the Esplanade and Charles Cricle can only be reached via level-changing bridge connections. Although the total number of people living or working adjacent to the northwestern Esplanade might be lower than in Beacon Hill and the Back Bay, these described inferior pedestrian connections and the perpetual heavy traffic between Charles and Leverett Circles could be viewed as the primary reasons why this portion of the park is so much less popular than the "main" Esplanade.

Second, Charles Circle is dominated by vehicular traffic which inhibits free, safe and enjoyable pedestrian movements on the surface level. Pedestrian signals have been replaced by pedestrian overpasses which link the two Cambridge Street "shores" with the

Charles Street MBTA station, and Charles Circle with the Esplanade. Although the pedestrian bridges connect most of the pedestrian "mainland" with the Charles Street Station, the overhead connection is not satisfying in many respects. First, for elderly and less able-bodied people, the ascent to and descent from the bridge's heights are a sheer insurmountable task. The stairs leading to and from the overpasses are steep, narrow and often slippery after rain or snowfall. Second, not all "shores" are served by the overpasses. The northern sidewalk along Longfellow Bridge, for instance, connects only to the Eye and Ear Infirmary parking lot, yet another pedestrian unfriendly environment. Some daring pedestrians follow the one foot wide sidewalk all the way to the circle only to find themselves confronted by high-speed traffic spilling into the circle from the Storrow Drive westbound off-ramp. Third, whether it is only a dislike for climbing stairs or the psychological disinclination to completely relinquish space to the automobile, people prefer walking on the surface level.[62] The manner in which pedestrians are separated from vehicles symbolizes that the surface area belongs to the automobile. Although all activity centers, apart from the MBTA station, are on the ground, pedestrians are moved onto another level to make way for vehicular traffic. This design establishes a hierarchy by mode which in effect reduces people's desire to walk and their enjoyment of the same.

Third, as many reports have indicated, sidewalks in several places are too narrow.[63] On the Longfellow Bridge's widely used south sidewalk there is inadequate space for pedestrians, joggers and those bikers who wish to stay off the dangerous roadway. Along Cambridge Street, the southern sidewalk is too narrow in several places and pedestrian flows are repeatedly interrupted by alleys, gas stations and cross streets. On the north side of Charles Circle, employees of MGH, the largest employer in Boston save the city itself, who use transit daily have to walk along a narrow footpath to their workplace. Although a report indicates that LOS A or B is consistently achieved for pedestrians on either sidewalk and at pedestrian crossings along Cambridge Street, this statistic is not particularly useful in measuring the friendliness of the pedestrian environment. First, narrow sidewalks act as a constraint on total volumes. If a pedestrian environment is not pleasant, people will either choose to walk elsewhere or not walk at all. Second, most pedestrian crossings along Cambridge Street have split signal phasing. This means that although crossings are wide and distances to be crossed during one phase quite short, it requires two phases to cross the entire width of the street which many pedestrians perceive as a negative feature.[64]

It is apparent from the comments by many who use this area on a regular basis that the current situation does not cater to the needs of pedestrians, the local residents, shoppers and strollers. Many find the area unpleasant and even threatening, a perception elicited and reinforced by the visual appearance and design of Charles Circle.[65]

2.1.4. Image

A survey conducted by the Beacon Hill Civic Association in 1991 provides an overview of the which features of this environment are deficient according to those who reside or operate businesses in its vicinity. The comments by those responding to the questionnaire underline that people are commonly dissatisfied with the area's visual blight, poor design, safety and pedestrian environment.[66]

Charles Station seems isolated and removed from its passengers with the overhead walkways reinforcing the sense of separation and difficulty of reaching the station. The MBTA Red Line trains which move on an elevated structure above the traffic circle generate significant noise when they pass by. The structure itself, with the exception of the copper-plated station, looks dilapidated and grey, blocking views and shading pedestrian areas beneath.

The unsightliness of Charles Circle spills over into Cambridge Street which forms a sharp boundary between the historic Beacon Hill district and the Massachusetts General Hospital/West End districts. The 1920s widening of the street and urban renewal of the West End and Government Center in the 1950s and 60s had a tremendous impact on its character.[67] The transformations brought about by these developments are in part responsible for the street becoming a "symbolic separation"[68] between two now completely disparate urban landscapes.

The existing streetscape lacks visual clarity, coherence and unity. The accumulation of overhead structures — Longfellow Bridge, the Red Line elevated structure, all pedestrian bridges, as well as traffic signs and signal controls — block views and give Charles Circle a incohesive and cluttered appearance. Inhibition of pedestrian circulation, encroachment upon open space as well as interruption of sightlines have all contributed to making the river and Esplanade seem more remote and distant.[69] Therefore, although only several feet away from the Charles River, Charles Circle fails to establish a vital connection to the water and park.

2.2. Arlington/Berkeley Ramp Area

In this section, the focus of analysis is on the segment of Storrow Drive between Massachusetts Avenue and the Arlington Street off-ramp, depicted in **Figure 2.2-1**, which are the western and eastern borders of the Back Bay. While the analysis focusses primarily on the area where Storrow Drive ramps connect with Beacon Street and the Back Bay — at Clarendon, Berkeley and Arlington Streets — a description of the environment along Back Street — a service alley between Beacon Street and Storrow Drive — is also included in this section.

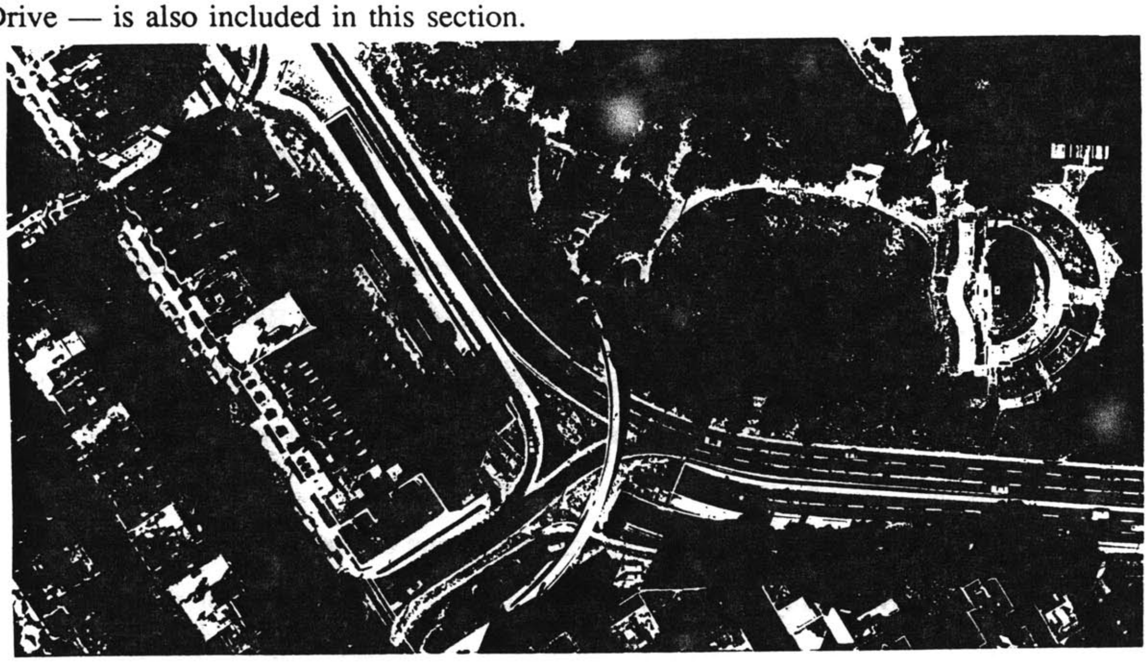


Figure 2.2-1. Aerial View of the Arlington/Berkeley Street Ramp Area.

2.2.1. Transportation

Storrow Drive connects to the Back Bay surface street system at several locations between Massachusetts Avenue and Embankment Road. Access into the Back Bay occurs via the Arlington and Clarendon Street off-ramps from Storrow Drive for eastbound and via the Arlington Street off-ramp for westbound vehicles. Average weekday traffic (AWDT) volumes on these ramps were depicted in **Figure 1.2-8** and add to a total of 31,000 in 1987, with about two-thirds of these vehicles coming from the Northeast. Berkeley Street, on the other hand, serves as the principal access link to Storrow Drive from the Back Bay and points south with volumes of about 25,000 in 1987. An additional 6,000 vehicles, according to the assignment, access Storrow Drive eastbound via Embankment Road, the only other entry point along this section of the expressway.

Dartmouth Street, in the early decades of this century, was planned to be the main South-North arterial between Massachusetts Avenue and Charles Street and was frequently suggested as a possible corridor to approach a third bridge across the Charles River to Cambridge.[70] These plans emerged during a period when planners, in search for ideas on how to develop the basin, circulated proposals for an island in the Charles River Basin. As late as 1948, Dartmouth Street was proposed as the principal access corridor to westbound Storrow Drive with a westbound on-ramp but this plan was not realized in the final configuration of Storrow Drive.[71]

Changes of the initial configuration have been proposed several times over the past years, especially the closure of the Dartmouth Street eastbound exit.[72] Among the other proposals were the addition of a Clarendon Street exit from westbound Storrow Drive[73] and the closure of both the westbound Arlington Street exit and Beacon Street connection to Embankment Road.[74] None of these plans, except for the closure of the Dartmouth Street eastbound off-ramp, have become reality, however, and connections have remained virtually the same since Storrow Drive's inception in 1951.

The Arlington/Clarendon Street corridor is one of the two main travel routes into and through the Back Bay. Beacon Street, carries a large number of vehicles from the city core to the Embankment Road on-ramp and points west. Since two major corridors cross at this location, the intersection of Beacon Street with the high-volume off-ramps from Storrow Drive, the Embankment Road on-ramp and Arlington Street is highly utilized. This intersection operates at level E with volumes of 3,800 vehicles in the afternoon peak and arterial LOS F from the Beacon street approach.[75]

With these ramps constituting the primary regional connections to the commercial area around Prudential Center and Copley Square, major cross-traffic through predominantly residential districts on Arlington, Berkeley and Clarendon Streets traverse the Back Bay in North-South direction at its eastern end.

2.2.2. Open Space

The land which was taken to create Storrow Drive some forty years ago was replaced by parkland filled into the Charles River in the form of little connected islands. Although this meant that there was no net loss in open space area along the river, its accessibility, primarily for people in the West End, has been significantly reduced. The construction of the wide high-volume roadway has greatly diminished the quality of this open space and the Charles River. In spite of the fact that Storrow Drive is partially in a tunnel in the vicinity of the ramps, this has neither enlarged the park area nor improved the ease with which pedestrians can reach the Esplanade. The primary reason for this is that the tunnels were designed to allow turning movements of vehicles without interrupting the flow of traffic, rather than to provide a corridor for pedestrian passage to the park. Instead of creating more open space, fragmented pieces of land, which are inaccessible or unusable, are scattered between ramps, boat sections and a service road, Back Street. If one actually added all these pieces together it would yield an area of approximately 1.5 acres or about the size of an entire football field.

The Esplanade between Massachusetts Avenue and Charles Circle is the most widely used of the many miles-long river park. Walkways and strips of lawn along the lagoons are regularly filled with people, and the popular Hatch Shell, which has been used for outdoor performances for over 50 years, is visible from the corridor where the expressway ramps are located.

Across Beacon Street, just to the southeast of the Esplanade, lie the Public Garden and Boston Common. The garden was completed in 1860 and, together with the Common, is used by thousands of people every day walking between downtown locations. With the completion of the Fens in the 1890s and the Charles River Embankment in the 1910s, the Back Bay was framed by parks on three sides.[76] However, the green necklace has suffered from encroachments in the last decades. Both the Public Garden and the Common are surrounded by multi-lane arterials, partially isolating them from the rest of the city and making them very contained spaces within the central area.[77] While the Public Garden and Common appear at least somewhat as a single open space entity because of a long common edge along Charles Street, the Esplanade and Public Garden open spaces have no such coherence. It could be seen in **Figure B-4** that in spite of the fact that the ramp corridor and Arlington Street are not exactly alinged, a visual connection between these two parks was more obvious half a century ago. The loss of contiguity which has resulted from the transformation of this area into a major highway node has fragmented the open space into unrelated pieces of an otherwise coherent park system.

2.2.3. Pedestrian Circulation

This loss of connectedness is especially felt by pedestrians. Currently, two major deficiencies hamper a successful linkage between these two parks. First, Beacon and Arlington Street are heavily travelled multi-lane arterials. The intersection at Arlington and Beacon Street is confusing for some because Beacon Street is two-way for a short segment, and difficult to manage for pedestrians. A total of five one-way, high-speed lanes have to be crossed to reach the northern sidewalk of Beacon Street from the Public Garden, a deterrent for especially slower walkers. Second, the pedestrian bridge across Storrow Drive spans about 600 feet (including the slopes of the ramps on either side), a distance equivalent to almost one East-West block in the Back Bay, although the width of roadway crossed is only about 60 feet. Thus, as is the case at Charles Circle, while the Esplande is physically close to Beacon Street, a sense of separation is experienced through the difficulty of actually making this connection by foot.

As is the case at Charles Circle, this environment is laid out to serve automobiles with pedestrian movements confined by the barriers established to move traffic swiftly and safely. The pedestrian bridge crossing Storrow Drive and Embankment Road cannot soften the sense of isolation generated by the high-speed, high-volume roadway. Overpasses to the west of the off- and on-ramps have even less potential to improve the connection between the Esplanade and the abutting neighborhoods since they originate in a blighted, pedestrian-unfriendly environment with no obvious connection to the rest of the neighborhood. Storrow Drive bears some responsibility for the perpetuation of a Back Bay which backs the Charles River. The noise and high volumes on this roadway continue to act as a disincentive to create a more open and pedestrian-friendly atmosphere along the rear yards of these houses.

To the West of the area characterized by ramps and tunnels, one finds similar problems. Although Dartmouth Street was converted into a one-way street with a pedestrian mall on its western side, the lack of continuation of the wide sidewalk north of Beacon Street — primarily a consequence of the narrowed block width north of Beacon Street — also reduces the potential to establish a connection between the Esplanade and the Back Bay. With no adequate provision of pedestrian linkages north of Beacon Street, the separation caused by Storrow Drive is strongly reinforced. Therefore, the pedestrian realm of the Back Bay seems to cease at Beacon Street where blocked nodes prevent a continuation of movement, both physically and psychologically, to the Charles River.

2.2.4. Image

In his book *The Image of the City*, Kevin Lynch describes how people in Beacon Hill relate to the Charles River:

> "Some relation to the Charles River was sensed by almost everyone, [...] but the detailed linkage was quite unclear, because of the dubious classification of the lower area [...] and the difficulty of crossing Storrow Drive to reach the water. The relationship with the river [...] seems to disappear as one approaches it."[78]

This statement might be similarly applied to the Back Bay. Several visual features pronounce the character of separated spaces in this area.

First, in the vicinity of the Storrow ramps, there is an accumulation of open boat sections, wide pieces of roadway, pedestrian overpasses and patches of 'dead' space squeezed between these. These disparate pieces of concrete, asphalt, steel and brown grass at the Arlington/Berkeley Street entrance/exit and to the West contribute to the area's cluttered appearance. Quite obviously, a walking person does not feel comfortable in this environment.

Second, there is no landscaping which would help in establishing contiguity between the two separated sides of Storrow Drive or between the Public Garden and Storrow Drive. Without the planting of greenery in this corridor or other provisions to create a contextual connection between the two, pedestrians and bicyclists experience the feeling of having to pass through a hostile environment before reaching the Esplanade or Public Garden.

Third, as pointed out before, the Back Bay turns its back towards the former bay. Back Street has its history from stubborn property owners in the last century who prevented the construction of another row of houses which would have made the block north of Beacon Street like all the others in the Back Bay.[79] Since this construction never happened, North Beacon Street residences still turn their backs towards the river. While the unsightliness of the Bay at some point in the history of creating the Charles River Basin might have been an important reason to orient these houses towards the city and backing the North, the damming of the Charles River and conversion of the banks into parkland later removed the rationale for this layout. Unfortunately, an opportunity was lost when the construction of Storrow Drive postponed decisions concerning the possible redesign of the backs of these residences. Back Street today is a shabby alley which serves these residents as a back access facility and for parking. Thus, for many it could appear that Beacon Street represents a northern limit to the area accessible from the Back Bay.

As is the case with Charles Circle, these elements of unsatisfactory urban design are mutually dependent and amplify each other. Splintered pieces of inaccessible land, no recognizable pedestrian connections, unpleasant environments and the careless design of the strip of land abutting the expressway all contribute to aggravate the Storrow Drive barrier.

2.3. Charlesgate

Charlesgate lies at the western edge of the original estuary. While the conversion of the original bay to a fresh water basin about three-quarters of a century ago modified the character of this orginal saltmarsh to some degree, some developments in the past decades have radically transformed this area.

2.3.1. Transportation

The gate to the Charles River from the Fenway and Muddy River was slammed shut and bolted when a generation ago the Charlesgate interchange was constructed (**Figure 2.3-1**). The Bowker overpass, named after Senator Bowker who was a key actor

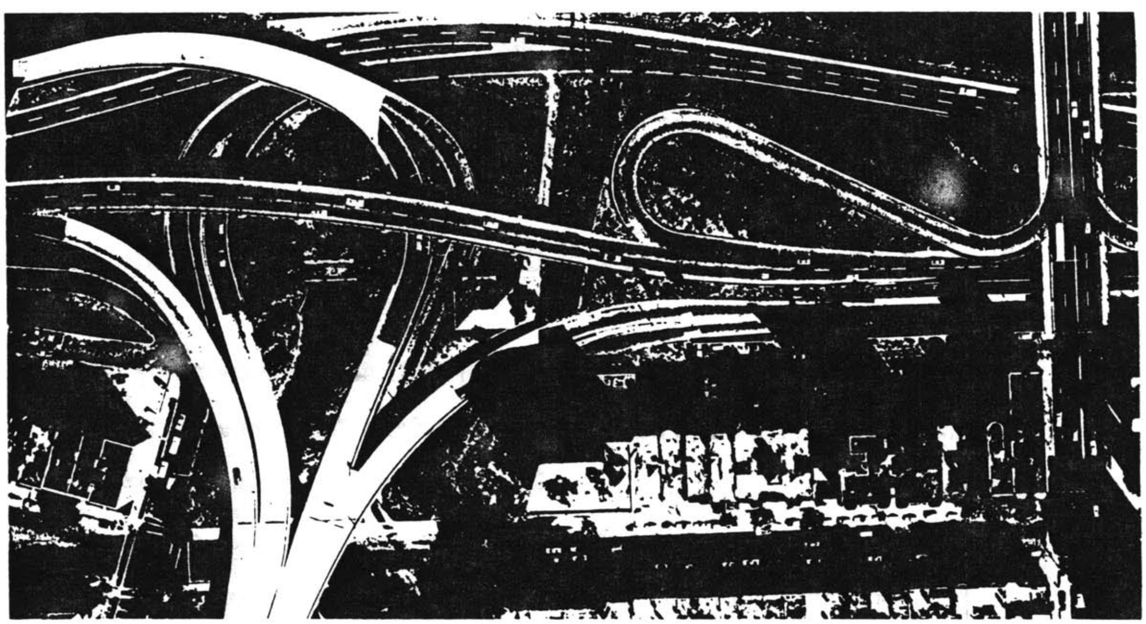


Figure 2.3-1. Aerial View of Charlesgate and Harvard Bridge.

in promoting the construction of the Storrow Drive expressway, has been viewed as the "most damaging alteration to the Back Bay Fens"[80] which destroyed the so-called Beacon entrance. Built in 1965, the massive viaduct construction over the Muddy River connects Storrow Drive with the Kenmore Square surface system, the Fenway and points to the Southwest. The already ambitious Arthur Shurcliff[81] design of 1929, shown in **Figure 2.3-2,** was revised in 1949 by the same to be more compatible with highway standards of the postwar years.[82]

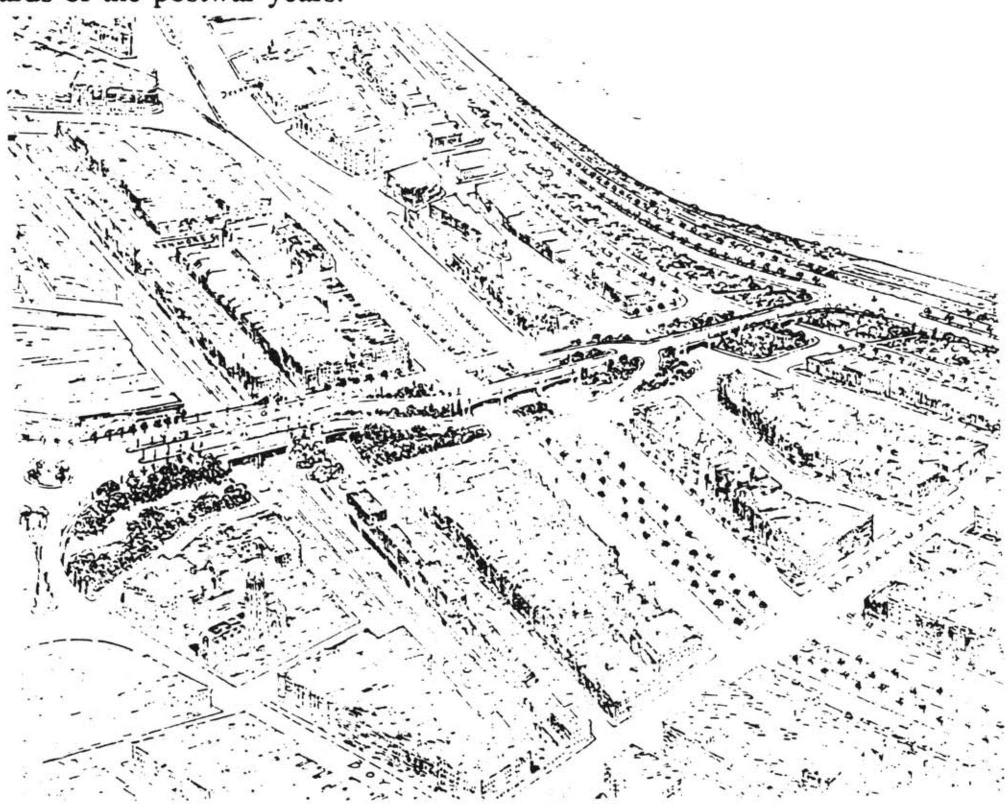


Figure 2.3-2. Bird's Eye View of Charlesgate by Arthur Shurcliff, 1929.

About 70,000 vehicles use the overpass in 1987 and corresponding ramp volumes were shown in **Figure 1.2-10**. The ramps leading from this connector and distribution roads surrounding or going through the park are an important point of entry into the Back Bay-Prudential Area.[83] Because of this vicinity of major activity centers, Charlesgate currnetly performs an important regional transportation function. To the West are Kenmore Square and Fenway Park which during game nights attracts thousands of automobiles. To the South, the Longwood Medical Area (LMA) is a job-intensive and growing institutional district which has been one of the largest traffic generators in the past decade.[84] The Prudential-Copley area, as mentioned above, lies to the East, and much of the traffic from Storrow Drive and the Fenway merges on Boylston Street to access this area. Storrow Drive and the Charlesgate interchange currently serve as important regional highway links to and from points northwest and northeast into the Back Bay in addition to the Arlington/Berkeley Street ramps further east.

With several developments planned in this area, such as Olmsted Plaza, Boston University's Armory Building and several expansions in the Longwood medical area, several current local transportation studies have been published.[85] A snapshot of local intersection peak hour level of service characteristics developed for the Olmsted Plaza FPIR/FEIR in January 1990 is shown in **Table 2.3-1**. The data in the table indicate that without the development of an alternative transportation concept for local traffic circulation, the next decade will witness a severe increase in local traffic congestion in the Kenmore Square/Fenway/Longwood area. This is among the reasons why various planning agencies have been pushing for the improvement of public transit service, preferably in the form of some kind of circumferential rail construction.[86]

		1989 EXISTING		1995 NO-BUILD	
SIGNALIZED INTERSECTIONS		DELAY SEC.	LOS	DELAY SEC.	LOS
1. Park Dr. at Beacon St.		79.44	F	108.73	F
2. Park Dr. at Riverway		8.09	B	10.26	B
3. Fenway at Brookline		96.78	F	148.60	F
4. Park Dr. / Brookline Ave. / Boylston St.		38.34	D	52.00	E
5. Brookline Ave. at Longwood Ave.		657.52	F	1000+	F
6. Riverway at Longwood Ave.		1000+	F	1000+	F
7. Kenmore Square		116.22	F	140.11	F
8. Boylston St. at Park Dr.		1.79	A	1.92	A
9. Fenway at Avenue Louis Pasteur		UNSIG.	C	UNSIG.	D
10. Huntington Ave. at Louis Prang & Ruggles St.		32.20	D	531.89	F
11. Brookline Ave. at Fullerton St.		UNSIG.	A	UNSIG.	B
12. Riverway at Brookline Ave.		53.15	E	104.40	F
13. Park Dr. at Fenway (Boylston St.)		16.00	C	33.76	D
14. BU Bridge at Commonwealth Ave.		902.19	F	1000+	F
15. University Rd. at Commonwealth Ave.		60.90	F	68.19	F
16. Evansway at Fenway and Louis Prang		69.57	F	104.17	F
17. Charlesgate W. at Beacon St.		14.07	B	17.45	C
18. Charlesgate E. at Rte. 1 off ramp		18.08	C	20.11	C
19. Beacon St. at Maitland St. & Mountfort St.		UNSIG.	A	UNSIG.	A
20. Beacon St. at Miner St. & Arundel St.		UNSIG.	A	UNSIG.	A
21. Riverway at Fenway'		UNSIG.	C	UNSIG.	C
22. Park Dr. at Avenue Louis Pasteur'		UNSIG.	C	UNSIG.	C
23. Park Dr. at Site Entrance		3.83	A	3.97	A
24. Carlton St. at Mountfort St.		1000+	F	1000+	F
25. Boylston St. at Ipswich St.		10.07	B	11.51	B
26. Longwood Ave. at Chapel St.		12.71	B	14.74	B
UNSIGNALIZED INTERSECTIONS		RC	LOS	RC	LOS
9. Fenway at Avenue Louis Pasteur	NB Right	460	A	424	A
	WB Left	220	C	171	D
11. Brookline Ave. at Fullerton St.	EB Left	693	A	663	A
	SB All	420	A	376	B
19. Beacon St. at Maitland St. & Mountfort St.	CLV =		A	722	A
20. Beacon St. at Miner St. & Arundel St.	CLV =		A	741	A
21. Riverway at Fenway	Merge				
22. Park Drive at Avenue Louis Pasteur	Merge				
NO. of INTERSECTIONS at LOS A,B,C,D =			16		14
NO. of INTERSECTIONS at LOS E,F =			10		12

Table 2.3-1. Afternoon Peak Hour LOS for Selected Intersections Near Kenmore Square.

Today, rail transit service in the immediate vicinity of Charlesgate is limited to service by the MBTA Green Line which branches out beyond Kenmore Square to connect Brookline, Newton and Riverside with Boston downtown. Limited central tunnel capacity on the Green Line places an upper threshold for passenger growth on this corridor in the future.[87] Therefore, the inception of parallel or circumferential transit service or addition of a commuter rail stop has flared up around the question of how future increases in travel could be absorbed by transit in this area.

2.3.2. Open Space

The Fenway and Muddy River lie at the heart of Frederick Law Olmsted's plan for a continuous park system. While the expansion of arterial streets lining the open spaces have damaged the necklace to varying degrees, the obstruction of the river mouth at Charlesgate has completely obliterated the notion of a contiguous system. The Charlesgate interchange has cut off all natural and pedestrian connections to the river, covering up the Muddy River and blocking physical passage by a forest of ramps. The overhead viaducts of the Bowker overpass cast their shadows upon the area beneath them and pronounce the cessation of this link between the Fens and the Charles River. The "open" spaces squeezed between ramps and structures are not truly open as they are disjoint and connect with neither the Esplanade for the Fenway. In addition, the Massachusetts Turnpike with its eight lanes of traffic over the Muddy River pronounces a separation created by a rail corridor through the Fens more than a century ago.

When Olmsted designed the Fens, he designed them in a fashion to reflect their history as saltmarshes. A comparison of the original design of the Fens and what they look like today is shown in **Figure 2.3-3** and **Figure 2.3-4**. The marshy environment serves less as recreational space for residents than providing the image of an urban wild. In recent years small urban gardens have been developed to the south of the Boylston Bridge over the Fens as part of a rehabilitation program. This program was authorized by the state legislature who approved $15 million in 1983 for the Olmsted Historic Landscape preservation Program targeting among other programs improvements to the

Back Bay Fens, the Muddy River and other parks in the park system.[88] However, to the north of this bridge, a jungle of ramps at the interchange with Storrow Drive, a flyover and freeway have virtually and consumed all the open spaces enjoyable to the public. The Muddy River itself is a stagnant cesspool to no one's liking.

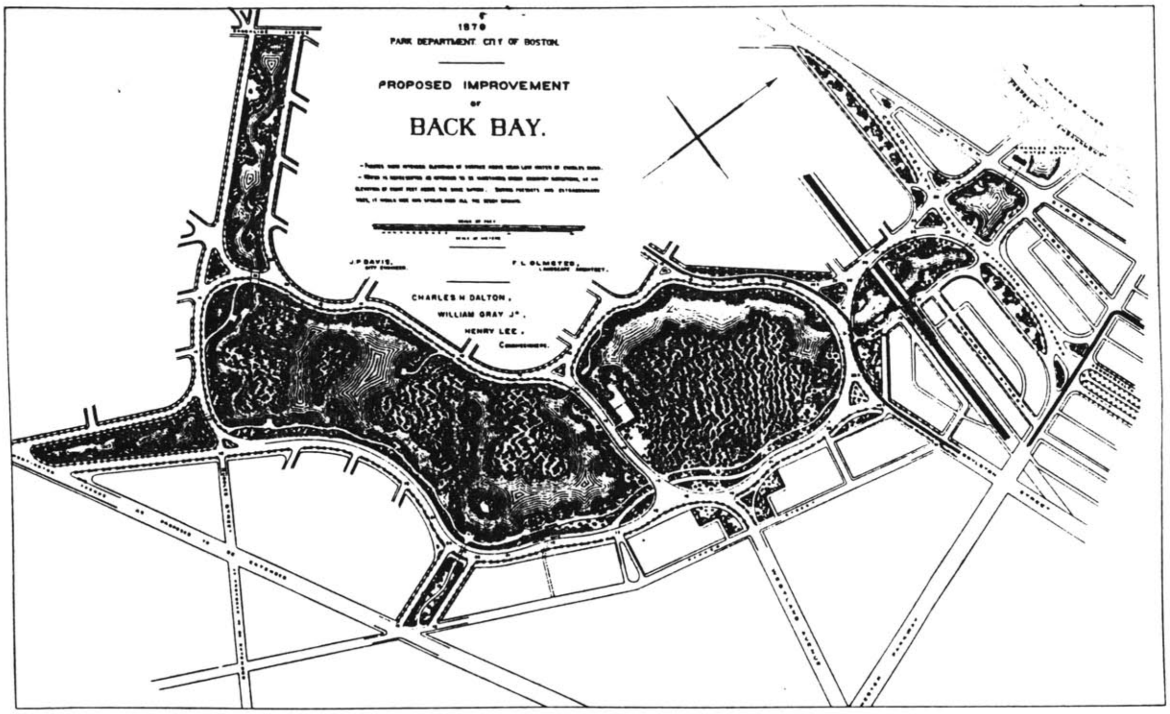


Figure 2.3-3. F.L. Olmsted's First Published Plan for the Back Bay Fens, 1879.

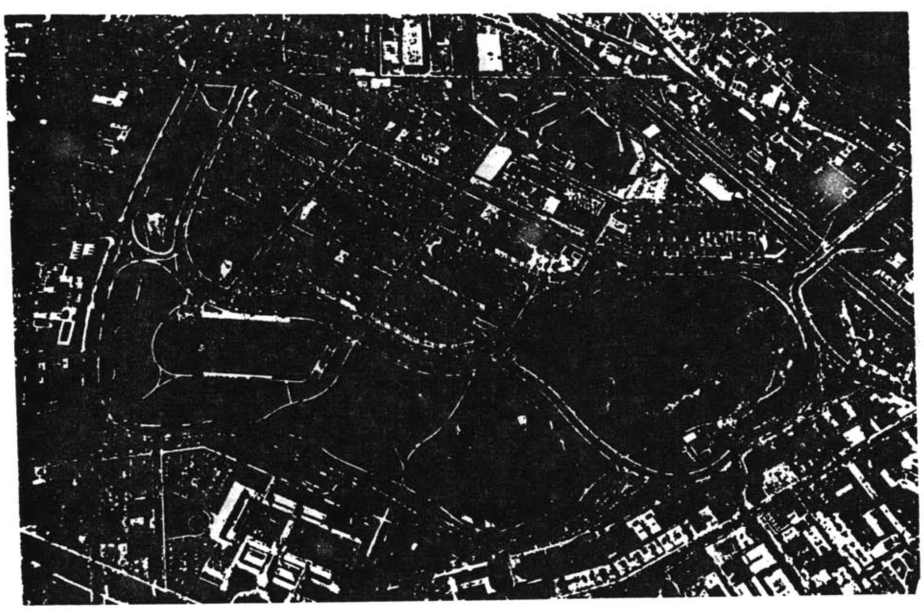


Figure 2.3-4. Aerial View of the Back Bay Fens and Charlesgate, 1982.

The Esplanade narrows to a small footpath to the north of the interchange. As is the case with the areas underneath the Bowker overpass, this area can hardly be classified as a park anymore. Parks, as Olmsted put it, are places

> "...where [people] shall find the greatest possible contrast with the restraining and confining conditions of the town, those conditions which compel us to walk circumspectly, watchfully, jealously, which compel us to look closely upon others without sympathy."[89]

Charlesgate might be one of the most blatant examples of a park design which has been obliterated through transportation facilities. One is tempted to inventory the park system here as a sliver of park along Soldiers Field Road to the West, the Esplanade to the East, the Fens to the South and some ludicrous patches of closed space in between.

2.3.3. Pedestrian Circulation

Charlesgate together with the Harvard Bridge mark the western boundary of the central Esplanade. Although the river park continues for miles to the West, its narrowing to a small footpath between the pillars of hovering highway ramps sever the connection between two now disparate environments. The Esplanade to the East of Harvard Bridge is likely to derive its popularity for pedestrians and bicyclists from the fact that walkways exist which are not in the immediate proximity of the highway. Escaping from the noise and agitation of city life, as Olmsted is quoted above, is one of the great reliefs sought by pedestrians.

While it is still possible, if unpleasant, to walk between the two "Esplanades," the river cannot be reached from the city at all. Sidewalks along Charlesgate East and West terminate at Back Street and do not connect to the river walkways at. To access the Esplanade from Kenmore Square or its adjacency, one can either walk west to Sherborn Street which has a pedestrian bridge leading to the water, or east to walk along Massachusetts Avenue and use a newly added pedestrian/bicycle ramp from the Harvard Bridge. As was the case in the Back Bay, the lack of both physical and visual connections to the Charles make Beacon Street appear as the northern periphery of the walking district.

Appearing more like an alibi concession by the MDC for constructing the Bowker overpass than an environment designed for pedestrian rummaging, the patchy spaces underneath the highway structure are sprinkled with little footpaths and benches. If use is a good indicator of the popularity of a particular environment for pedestrians then, not surprisingly, Charlesgate is not a popular place. In addition to the very confined space and heavy traffic, the shadows cast by the wide overhead structure might deter people from walking along the remnants of Muddy River.

Many of the original strolling paths seaming the Fens have disappeared and high-volume traffic often makes pedestrian access to the park extremely difficult and dangerous.[90] The one-way configuration of most of the roads originally designed as parkways is one of the reasons for the frightfully high speeds of vehicles — congestion aside — driving along the park. This fact and the inadequate design of some of the major intersections in this area, significantly reduce the quality of the pedestrian environment.

In the same manner that open spaces were fragmented and obliterated through the construction of transportation facilities, pedestrian movements have been severely curtailed and limited at Charlesgate. As the splintering of open space has created an agglomeration of enclosed spaces, it has also isolated previously connected pedestrian environments.

2.3.4. Image

What Charles Circle, the Arlington/Berkeley Ramp Area and Charlesgate have in common is that they are areas designed to move vehicles. Open space and pedestrian circulation are attached as "second" thoughts, and the physical and visual environment reflects this hierarchy of planning. Large, grey overhead structures give the person underneath the feeling to be small and unimportant, rubble and clutter spread a sense of lacking care for the surroundings. Vehicles moving at high speeds not only require larger and better facilities but also intimidate non-motorized individuals fighting for scarce urban space.

As is the case with other sections along Storrow Drive, the environment is generally pleasant from a driver's point of view. Looking down from the Bowker overpass, one can catch a brief glimpse of the beautiful Boston skyline and, going north, an exciting approach to the Charles River. These views are only a measure of the grand connection which has been destroyed. While the intrusive effect of overhead highway structures is often accompanied by the simultaneous use of the shadowed space underneath for parking, as is the case with the Charles Circle ramps and the current Central Artery, no cluttered parking facilities girdle the space below the elevated structure at Charlesgate. The area is relatively well maintained and boasts beautifully designed bridges across the Muddy River. Fair attention has been paid to some of the details such as street lights and bridge railings. Interesting house facades along Charlesgate East and West further contribute to make this area visually attractive. Considering the limitations, the visual appeal of this location is less disconcerting than that of Charles Circle and the ramp area at Embankment road.

Nevertheless, at Charlesgate the city is divided between the East and the West, and between the North and the South. Kenmore Square is detached from the Back Bay in spite of Commonwealth Avenue which was originally designed as one of the chief connectors to the city. The neighborhoods are isolated from the Charles River by the interchange which blocks view and access to the Esplanade and the connection to the Fens is weakened by the non-depressed Massachusetts Turnpike right-of-way. It is therefore a sad irony that this location should be called Charles"gate," when it is one of the most "plugged" entrances to the Charles in all of Boston.

The construction of transportation facilities in several locations has incurred a major cost in terms of reducing the quality of the surrounding urban environment. These costs are most visible in the shrinking and fragmentation of open spaces, the limitation of pedestrian movements and an abstraction of previously coherent pieces of the urban fabric. Is this the price of mobility which urban residents and workers must pay?

Part II
Envisioning a Future Storrow Drive

The above analysis has illustrated the extent to which Storrow Drive in its current form and with its present connections at key nodes constitutes a barrier between the residential and commercial areas of the Back Bay and Beacon Hill and the open space along the Charles River. Part II examines possible methods by which a better physical, visual and psychological connection between the Back Bay/Beacon Hill neighborhoods and the River Esplanade could be established. *The basic notion is that this linkage would be best achieved in the future by reducing the current role of Storrow Drive.* Thus, the design modifications explored in this context are different versions of a downgraded Storrow Drive some of which would make it more comparable in character to Commonwealth Avenue in the Back Bay and in size to Memorial Drive in Cambridge.

Although parts of the proposals are worked out in detail, especially some of the pedestrian connections at Charles Circle, the *objective is to deliver the conceptual ramifications* required to stimulate a focussed discussion with members of the affected communities about which futures are desirable and appropriate for the locations under investigation. Through the intensive and participatory process involving the local residents and businesses who know more about the particularities of their immediate environment than I could ever acquire in a 8-month period of research, these ideas could then be taken to their next logical stage.

A first step in thinking about which improvements could be made, is the development of *key concepts*, or themes, which can be translated into a list of *objectives* (Chapter 3.1). As a next step, it is illustrated how these concepts could be applied and materialize as *physical realities* at the selected focal points which were described in more detail in the previous sections (Chapters 3.2-3.4).

In Chapter 4, the transportation "price tags" of several downgrading scheme options are estimated. Traffic assignments on approximated versions of the modified network, replicating the features of the scheme under consideration, will focus on describing the traffic impacts of various downgrading measures in the local and regional system.

Chapter 3
Objectives and Options
For Downgrading Storrow Drive

There is a close relationship between what role Storrow Drive assumes as a transportation facility and its ability to better be integrated into the context of the urban fabric in which it is embedded. The greater the share of traffic allocated to Storrow Drive, the greater the division which will be created along this corridor. High volumes and speeds, uninterrupted flows, grade separations, overhead viaducts, lack of pedestrian connections, concrete barriers to set apart counter-directional movements, as were described in Chapter 2, are some of the critical features contributing to Storrow Drive's barrier image.

The history of ignoring the effects of highways on parks and people altogether, or their mere consideration as recipients of mitigative measures, has led to a severe reduction in important amenities in urban neighborhoods. It is obvious that the addition of lagoons in the Charles River as a mitigative "booby prize" for the users of the Esplande could never replace the value of an open space which had previously been easily accessible and removed from the blight and noise of the rest of the city. Therefore, a planning approach must be guided by the goal to preserve the greatest urban assets available to the people who depend on them.

3.1. Objectives

As a consequence of these considerations, it is proposed to reverse the traditional approach in urban transportation planning. Rather than looking for environmental design measures best mitigating the adverse effects of a planned transportation project, the intent here is to propose the downgrading of Storrow Drive as an environmental/urban design improvement and then find measures which minimize its negative transportation impact. Under this approach, a promotion of vitality and health of the urban environment, further supported by a recent innovation in transportation legislation, the Intermodal Surface Transportation Efficiency Act (ISTEA), assumes priority over marginal improvements in mobility.

The downgrading of Storrow Drive should lead to the formulated promotion of vitality of the urban environment. In particular, the re-establishment of better access to the river is envisioned to be realized through the achievement of the objectives following below.

3.1.1. Objective 1: Revitalize the Urban Park System

Open spaces are an integral part of the fabric of liveable cities.[91] When Frederick Law Olmsted proposed a park system in the late 1800s, known today as the 'Emerald Necklace', one of its key features was the interconnectedness and continuity of green spaces throughout the city. This was achieved by linking major parks via landscaped parkways or linear parks along natural features such as rivers. With few exceptions, such as the original Commonwealth Avenue and the newly created Dartmouth Mall, the idea of parkways or "boulevardized" roadways which serve pedestrian as well as vehicular movements has been widely lost. Essential connections between individual pedestrian-friendly environments which have been severed by high-volume thoroughfares or multi-viaduct interchanges should be re-established. The current redesign efforts at the Charles River crossing of the Central Artery, the open spaces freed up by the depression of the latter, as well as the ongoing development of proposals to revamp Allston Landing, are signs of a renewed effort to improve current park connections along the Charles River to Boston Harbor and to create new ones within the city.

3.1.2. Objective 2: Promote Pedestrian Circulation

Walking is one of the principal joys afforded by living in a dense urban setting. Boston's spatial layout supports pedestrian movement which is quite unique for an American city. Its small geographical scale, vital neighborhoods and a comparatively high level of land-use diversity in the proximity of the urban core render it ideal for pedestrian movements. Important activity centers in the city, the Boston Common and Public Garden, the waterfront and Charles River are all located close to each other which generally makes walking both interesting and a time-efficient alternative to other modes of travel. However, the advantages deriving from the spatial and activity density of the city is offset significantly for many connections by the absence of adequate pedestrian facilities. The difficulty of reaching certain destinations is especially pronounced along the corridor adjacent to the Charles River. A downgrading of Storrow Drive could reverse some of the damage created primarily in the 1950s and 60s and re-establish pedestrian linkages between the neighborhoods and the Esplanade through either open space corridors or signalized intersections.

3.1.3. Objective 3: Improve Urban Links and Design

To improve the quality of an urban area, disparate elements of the environment should be re-integrated visually and contextually. Open space linkages and pedestrian connections can both serve to integrate previously isolated pieces of the urban fabric. A successful design should mold transportation functions, open space, pedestrian circulation and visual clarity into a legible and identifiable whole.[92] The downgrading of Storrow Drive yields the potential to remove existing ambiguities and improve the design in locations which have been neglected in the past. Through a modification of its transportation function and the urban design improvements it could promote, Storrow Drive could be integrated contextually into the grid of the Back Bay and Beacon Hill surface street networks. Furthermore, an improvement of the appearance and layout of key nodes along this corridor could help to create symbolic gateways into Boston and between currently disjoint pieces of the urban web.

3.1.4. Objective 4: Expand Use of Public Transportation

The depression of the Central Artery and addition of the Third Harbor tunnel is not a project to accomodate more vehicular traffic in Boston. While in the course of the depression significant capacity is added to the central section of the highway, the State has a binding agreement with the Conservation Law Foundation (CLF) that radial capacity not be increased. This agreement further stipulates that a parking freeze be implemented and transit improvements be undertaken. The CA/T project must therefore be tied to complementary measures which will assure a reduction in vehicular traffic. This could be accomplished or successfully aided by a policy of contracting current roadway capacity on local streets and arterials which are now overloaded on a commensurate scale as capacity will be expanded on the Central Artery. Otherwise, as was shown in Chapter 1.2, the growth in automobile travel could lead to a significant increase in local congestion and substantially decrease the efficiency of the transportation system and quality of the urban environment. The Storrow downgrade is envisioned as one possible option where the opportunity afforded by the Central Artery project could be translated into real benefits for pedestrians and enhancements of open space amenities. Transit improvements, some of which are already planned or approved, must therefore be pursued vigorously to absorb future growth in travel in lieu of the automobile.

Beyond its sytem-wide relevance, transit is also directly linked to pedestrianism. It is complementary to walking in that it allows people to reach specific desinations, such as Charles Circle and the Kenmore Square area, from which they can access the Esplanade. Thus the provision of transit accessibility is an important addition to the removal of barriers along the river park, as is envisioned by a downgrading of Storrow Drive.

3.1.5. Objective 5: Remove Storrow Drive from Interstate Role

More a first step in achieving the first three objectives from above than an end in itself, Storrow Drive should be removed from the quasi-Interstate status it maintains today. In terms of its linkage function in the regional network, as well as psychologically, Storrow Drive is already part of the Interstate system. If growth in trip making continues, there is a reasonable chance that pressures will mount to increase Storrow Drive's capacity through widening or fancy viaduct connections at current bottlenecks.[93] Unless Storrow were to be depressed, an option which seems unlikely for a number of reasons,[94] a capacity expansion will have vast detrimental effects in terms of widening the already existing barrier between the Esplanade and adjacent neighborhoods. The Boston Extension of the Massachusetts Turnpike and the elevated Central Artery are sobering examples of how disruptive large highways can be in the context of otherwise vital districts of the city.

This objective can be achieved through the minimization of capacity at entry points, a reduction of the speed limit, the utilization of existing physical constraints in the roadway, such as underpasses and tunnels, as well as through the creation of a more pedestrian environment along its sides with crossing options at signalled intersections. This, as was pointed out above, will partially integrate Storrow Drive into the Back Bay and Beacon Hill surface network.

In the following subchapters, some possible ways to permeate the wall created by the Storrow Drive transportation corridor and at interchange locations are explored. It is illustrated how the above concepts and objectives are applied to the three focal areas at Charles Circle, at the Arlington/Berkeley Ramp Area, and at Charlesgate. The first, design options and open space, describes possible design modifications and shows how they could enlarge park areas or enhance accessibility of open space to the public. The second, improvement of pedestrian circulation, focuses on the effect these changes could have on creating pedestrian-friendly environments by making walking more efficient, safe and enjoyable. In this context the role of transit is explored as a complementary measure. Finally, integrative design and urban links gives some examples of design and contextual improvements which could make the area visually more attractive and help integrate it better into its abutting urban environment.

The design options explored in the following sections are possible translations of the concepts listed above. It should be stated again, that this development of ideas on how to establish better connections to the Esplanade and gain more accessible open space is based on the recognition that the actual realization will result from an informed and participatory process in which the residents, supported by professional staff, articulate their concerns and preferences as regards the role of Storrow Drive.

3.2. Charles Circle

In Chapter 2.1. I provided a snapshot picture of Charles Circle. Some of the deficiencies identified in that chapter were the expansion of the roadway deep into the Esplanade, the agglomeration of ramps and the parking lot nested in between, as well as the lack of adequate surface connections for pedestrians. This chapter explores to which extent these problems could be resolved through a better design.

3.2.1. Redesign Options

One design alternative for Charles Circle is shown in **Figure 3.2-1**. It has several key features:

First, all ramp viaducts are removed. Usually grade-separated rights-of-way are constructed to avoid having to regulate conflicting high-volume movements on the same plane. However, at Charles Circle all vehicles except for those on the Storrow Drive

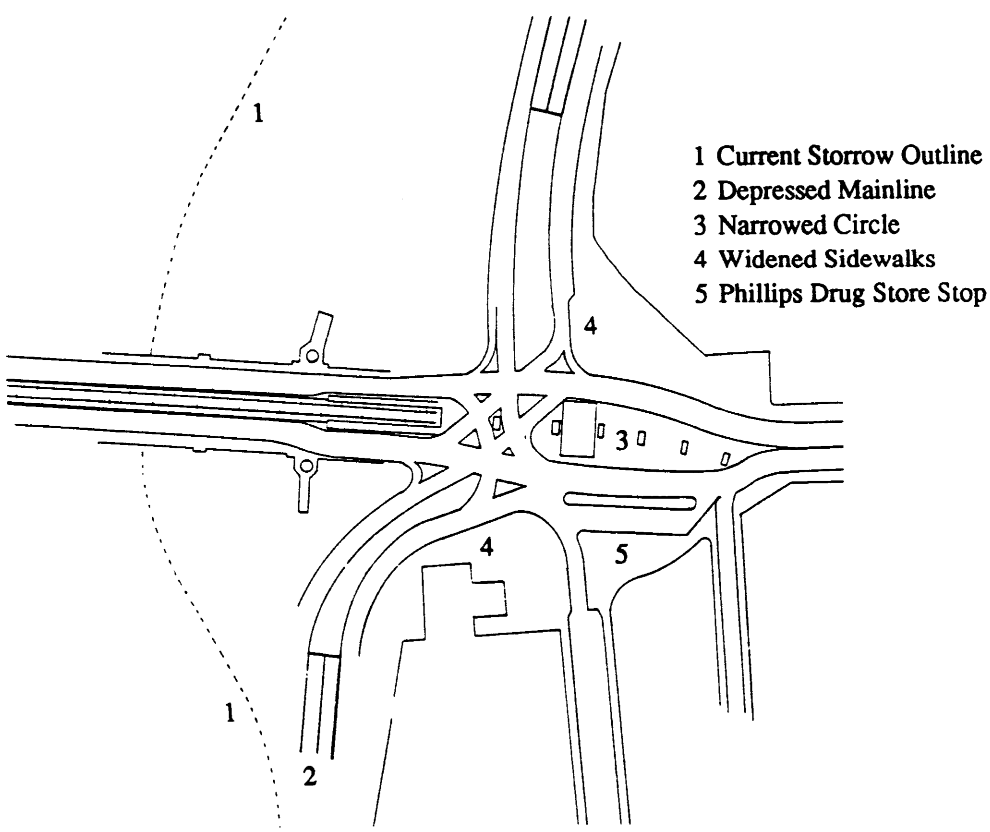


Figure 3.2-1. Redesign Option for Charles Circle with Depressed Mainline.

mainline must still pass through a signal-controlled quasi-rotary at grade. The configuration option, as depicted in the drawing, has turning and volume characteristics quite similar to those today. This implies that the elimination of ramps might not affect connectivity and intersection capacities per se.

Second, the Storrow Drive mainline is depressed, removing the current roadway segments reaching almost to the Basin's edge. By putting Storrow Drive in a tunnel under Charles Circle, the dangerous and space-consuming S-curve under the Longfellow Bridge is eliminated. In the drawing, the tunnel is four lanes, rather than today's five lanes wide, and Storrow Drive, under this downgrade option, would only be four lanes wide in its entirety.

Third, the Eye and Ear Infirmary parking lot is removed. Its closure has been proposed before because access to and egress from this parking facility in the proximity of a complex traffic circle and a high-speed expressway have been shown to be quite unsafe.[95] With the Massachusetts General Hospital planning to rebuild their aging parking garages — possibly replacing them by underground structures — a supply reduction resulting from the proposed plan could be circumvented.[96] However, in the longer run a reorganization of transportation services with greater emphasis on public transit tied to a limitation of additional parking supply should eliminate the need for such a replacement facility.

Fourth, the rotary design is obliterated. Charles Circle could be converted to an almost-normal intersection with "English" left turns instead of the current design with turning slots. This layout not only allows for a much narrower alignment of Cambridge Street but also simplifies turning maneuvers considerably. Confusion resulting from the current geometry would be minimized by this more traditional intersection design.

3.2.2. Open Space

One of the challenges of finding design alternatives for Charles Circle is how to reclaim some of the open space lost to the unsightly and complicated interchange. The presented option has multiple positive impacts on open space.

First, depression of the Storrow mainline frees up substantial areas of open space in the immediate vicinity of the Longfellow Bridge. This would help to connect the two isolated pieces of the Esplanade just to the North and South of this bridge.

Second, the removal of viaducts and the parking lot adds important park area to the current open space northeast of the Longfellow Bridge. In conjunction with the depression of the mainline, several acres of land could therefore be reclaimed for park usage, some of which on the site of the original Charlesbank Park designed by Olmsted in 1891.[97]

Third, a narrowing of the Cambridge Street alignment to a road just wide enough to pass around the transit station would yield additional space at the southern and northeastern periphery of the traffic circle which could be used as open and pedestrian space.[98]

The examined redesign of Charles Circle could add substantially to the existing open space to the West of the interchange. Its large positive open space effects are amplified by the fact that existing inaccessible or unusable space could be physically integrated either into the existing Esplanade or the sidewalks lining the intersection.[99]

3.2.3. Pedestrian Circulation

The *Bowdoin / Charles Transit Connector Project* identified three tasks to improve the pedestrian value of this area: a) increase total and effective sidewalk widths in locations of deficiencies, b) clarify and emphasize pedestrian crossing zones at Charles Circle and c) provide a safe and enjoyable environment.[100] While many factors which make this environment unpleasant to walk through are related to its visual appearance, as will be discussed in section three, the lack of safe and convenient connections at the surface level is the prime reason why pedestrian activity is limited at Charles Circle, considering its proximity to both the Massachusetts General Hospital and the Esplanade.

As the above report pointed out, "balancing travel times and safety for drivers and the design of a safe and pleasant environment for pedestrians is a significant challenge."[101] The version of a new Charles Circle presented here shows a design catering much more to the needs of pedestrians while maintaining comparable capacity levels for automobiles. As depicted in **Figure 3.2-1**, the design alternative could yield the following advantages:

First, direct connections from both sides of the Longfellow Bridge to the Esplanade are established through the removal of the peripheral western loop of the Storrow expressway. In addition to giving pedestrians on the northern bridge sidewalk a break from their original parking-lot-only destination, the illustrated design would allow this sidewalk to be expanded in its lower portion by about three feet to maintain the width it has on the bridge. This would adequately connect the sidewalk with a pedestrianized Charles Circle. On the southern side of the bridge, sidewalks could be widened by four feet narrowing the roadway to about 23 feet which is still sufficient width to allow two lanes of traffic to pass a disabled vehicle. This design of the bridge would correspond more closely to the sidewalk layout of the 1913 Longfellow Bridge, as is depicted in **Figure 3.2-2.**

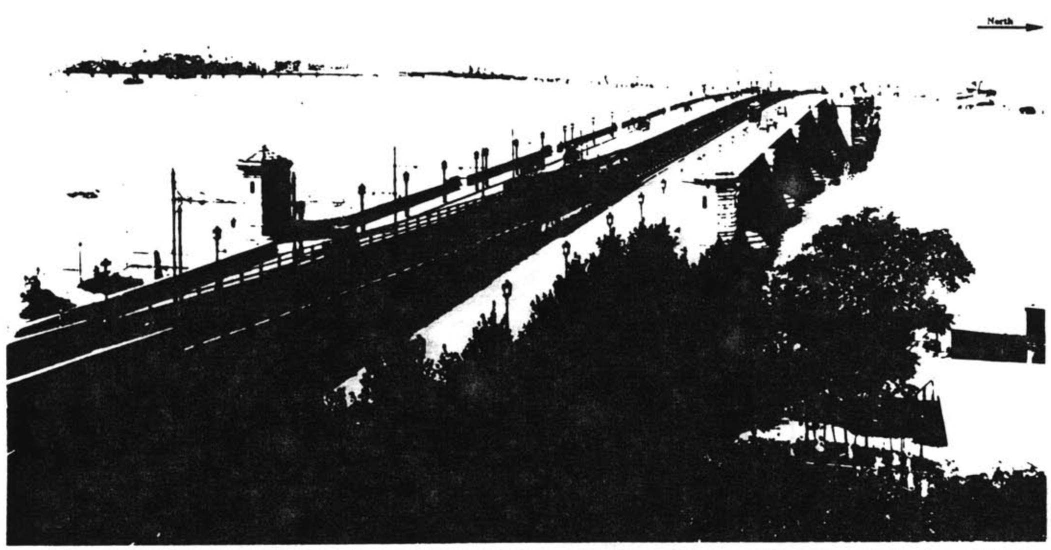


Figure 3.2-2. View of the Longfellow Bridge from Charles Circle, 1913.

Second, sidewalks could be widened along the periphery of Charles Circle to increase the amount of space for pedestrians and to more sharply define the edges of the roadway. **Figure 3.2-3** shows a reconfigured entrance to Charles Street with improved sidewalk geometry and better design.[102] Sidewalk widening, in addition to benefitting people who walk between Cambridge and Charles Streets, could also eliminate some of the confusion drivers experience in the absence of a clearly visible roadway geometry. The popular Phillips Drug stopping ground is delimited by a 8-foot wide traffic island creating an obvious separation between Cambridge Street and the stopping zone. Apart from clear advantages for drivers, this design would reduce the vast crossing distance between sidewalks for pedestrians and mark more clearly the boundary between pedestrian and vehicular territory. By reducing criss-crossing vehicular movements it also increases the safety for pedestrians and drivers alike.

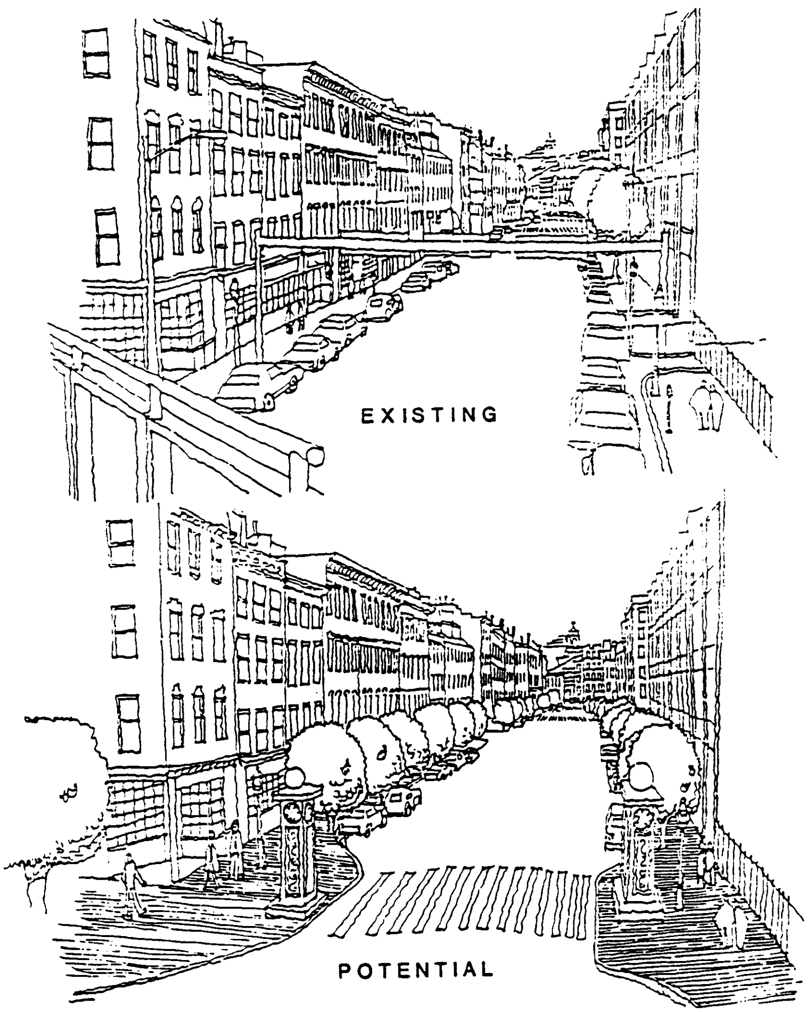


Figure 3.2-3. Possible Redesign for Charles Street Entrance from Charles Circle.

Third, the removal of the quasi-rotary and installation of a pedestrian-friendly signal system could make Charles Circle a more manageable place for out-of-vehicle beings. A three-phase signal system could be synchronized in a fashion to allow pedestrians to cross any entire width of roadway during a single signal phase — about 30 seconds. Slower pedestrians could use traffic islands and would never have to cross more than three lanes — today five — at a time. [103] Today, crossing at the surface is virtually impossible due to the intersection design and signal phasing.

Fourth, connections to the MBTA station on the traffic island could be established at the surface level with this design allowing the view-blocking pedestrian bridges to be removed. In the longer run, underground pedestrian connections, as proposed in the context of construction plans for a new Charles Station linking the Red and Blue Lines, could effectively augment signal-controlled surface movements.[104] The Charles Street Station serves as an important access node for MGH employees, neighborhood residents and visitors of the Esplanade. While this station is a substantial pedestrian trip generator, the geometric layout of the intersection and absence of surface connections currently prevent a pedestrianization of the circle. Therefore, the design shown in the drawing, in encouraging pedestrian activity on the surface will greatly improve the pedestrian-transit interface.

Finally, at three of the street corners small "plazas" are created through the narrowing of the roadway. These are large enough to accomodate a small street cafe or similar establishments which could contribute to greater pedestrian vitality in the area. In addition, with the conversion of the Suffolk Jail in the near future to a publicly accessible building, the area at the northeastern apex will be greatly expanded and become an area of major activity. Currently MGH employees and visitors arriving at the Red Line Station have to walk along a high wall surrounding the prison on a narrow sidewalk. In the future, the attractiveness of the new access into the MGH complex could significantly improve the sense of arrival for people coming by transit. It is these kinds of pedestrian improvements which in turn enhance the appeal of transit, a relationship which is reciprocal in that transit access can also contribute to creating lively pedestrian activity in the vicinity of stations, as was shown above.

Facilitating pedestrian movements on the surface has large positive effects for businesses at and adjacent to Charles Circle. Business owners along Cambridge Street seem eager to increase the importance of this corridor as a commercial district and have expressed the need to improve pedestrian circulation as most of their customers come by foot.[105] With the examined modifications, Cambridge Street increases its potential to thrive as a vehicular *and* pedestrian link between Faneuil Hall Marketplace, City Hall Plaza and downtown Boston to the East and the Esplanade and Charles River to the West. Pedestrians would help to humanize street traffic which in turn would start a process of vitalizing the area abutting the Esplanade. A redesigned, pedestrian-friendly Charles Circle could serve as a gateway to Boston and re-establish the connection to the Charles River.

3.2.4. Integrative Design and Urban Links

Charles Circle has long been an eyesore to many of the residents in the area. Many of the respondents to a survey conducted by the BHCA in 1991 expressed a dissatisfaction with the visual appearance of the elevated Red Line and the areas beneath the structure. Trashy and narrow sidewalks, unappealing store fronts and lack of pedestrian-oriented establishments were among the most frequently quoted complaints.[106]

Efforts to change the design of Charles Circle have been hovering around for some time, the most radical possibly the depression of the Red Line in its entirety from Cambridge to its current tunnel entrance under 15 Grove Street. Although the removal of the MBTA Red Line elevated structure would be desirable in terms of reducing the blocking of views, a large investment would be required which, considering that other transit plans are competing with such a project, makes its implementation quite unlikely. In addition, this would deprive many of the Red Line riders of a most beautiful view of the Charles River and Esplanade as they are passing over the Longfellow Bridge. Alternatively, and as suggested by several respondents to the Cambridge Street Survey, several smaller-scale improvements to the existing structure could help mitigate some of its negative impacts. Some specific improvement proposals have also been put forward independently by architects participating in the *Boston Visions* 1988 architectural competition.

The linkage of downtown Boston to the Charles River Basin relies heavily on the continuity established along the axes connecting the two. Cambridge Street could play an important role in making this connection if pedestrian activity along its sides were improved. Charles Circle then becomes an inviting portal to the City. The *Bowdoin / Charles Station Transit Connector Project* makes three specific proposals to improve the urban design at Charles Circle: a) protect and enhance views and sightlines which aesthetically benefit the area and benefit the visitor, b) orient urban design, landscape treatments and station design[107] towards the development of a strong, identifiable image for Charles Station and Charles Circle and c) visually and functionally unify splintered parkland parcels to reduce a perceived distance and remote nature of Esplanade from Cambridge Street.[108]

These suggestions are considered in the examined new design. Expansion of parkland, removal of overhead structures and increased pedestrian circulation all strengthen Charles Circle's symbolic role as an access point into the City by improving physical and visual connections to the Esplanade. The elimination of overhead ramp connectors and depression of the Storrow Drive mainline help to integrate this intersection into the surface network rather than making it appear as a higher-order roadway separate from the neighborhoods. In addition, the removal of the Suffolk County Jail walls and concurrent conversion of the jail building to an architecturally exciting piece of the urban topography in the near future will constitute a next step in making Charles Circle a visually more appealing and open area.

Small improvements, proposed perpetually by neighborhood organizations and the MDC[109], ranging from modest plantings and landscaping to improvements of so-called street furniture such as lighting poles and trash barrels make a significant difference once the environment can be reclaimed by pedestrians as envisioned in the proposed plan.[110]

As was depicted in the illustration of Longfellow Bridge in **Figure 3.2-2**, the 1906 design of the Longfellow Bridge was at a pedestrian scale with street lights illuminating sidewalks rather than the roadway. Similarly, as shown in **Figure 3.2-4**,[111] several minor design modifications could bring the environment in the current asphalt arena to a more human scale. In addition to encouraging pedestrian activity such improvements would enhance the vitality of Charles Circle as a node linking open space, residential and commercial uses. As a consequence, the currently chaotic and blighting Charles Circle could be re-integrated into its diverse and charming environment, making it an important focal point in the Boston urban system and an exciting gateway from water to city.

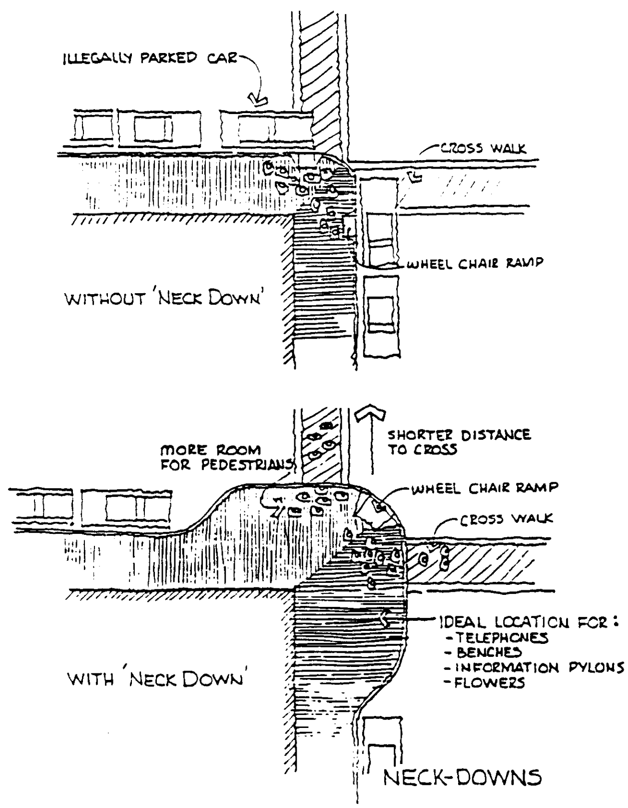


Figure 3.2-4. Possible Sidewalk Design Modifications, the 'Neck Down' Principle.

3.3. Arlington/Berkeley Ramp Area

In this section, analysis is focussed on the area where ramp connections are made between Storrow Drive and the Back Bay. In a more brief form, options to improve the seam between the Back Bay and Esplanade along Storrow Drive between Arlington Street and Massachusetts Avenue are examined.

3.3.1. Redesign Options

As was formulated in Chapter 3.1, the integration of physical contraints in the roadway configuration is an important element to achieve a lasting capacity reduction on Storrow Drive. The tunnels in the vicinity of the Arlington Street off-ramp can be converted to represent such a constraint while allowing for an expansion of the park.

A configuration option explored here is to use the existing tunnels in a different way while minimizing the need for physical reconstructions. **Figure 3.3-1** shows how the eastbound tunnel, between Clarendon Street and the westbound Arlington Street off-ramp, could be used in reversed direction for westbound traffic while the eastbound underpass under these off-ramps could serve as the mainline tunnel for eastbound traffic.

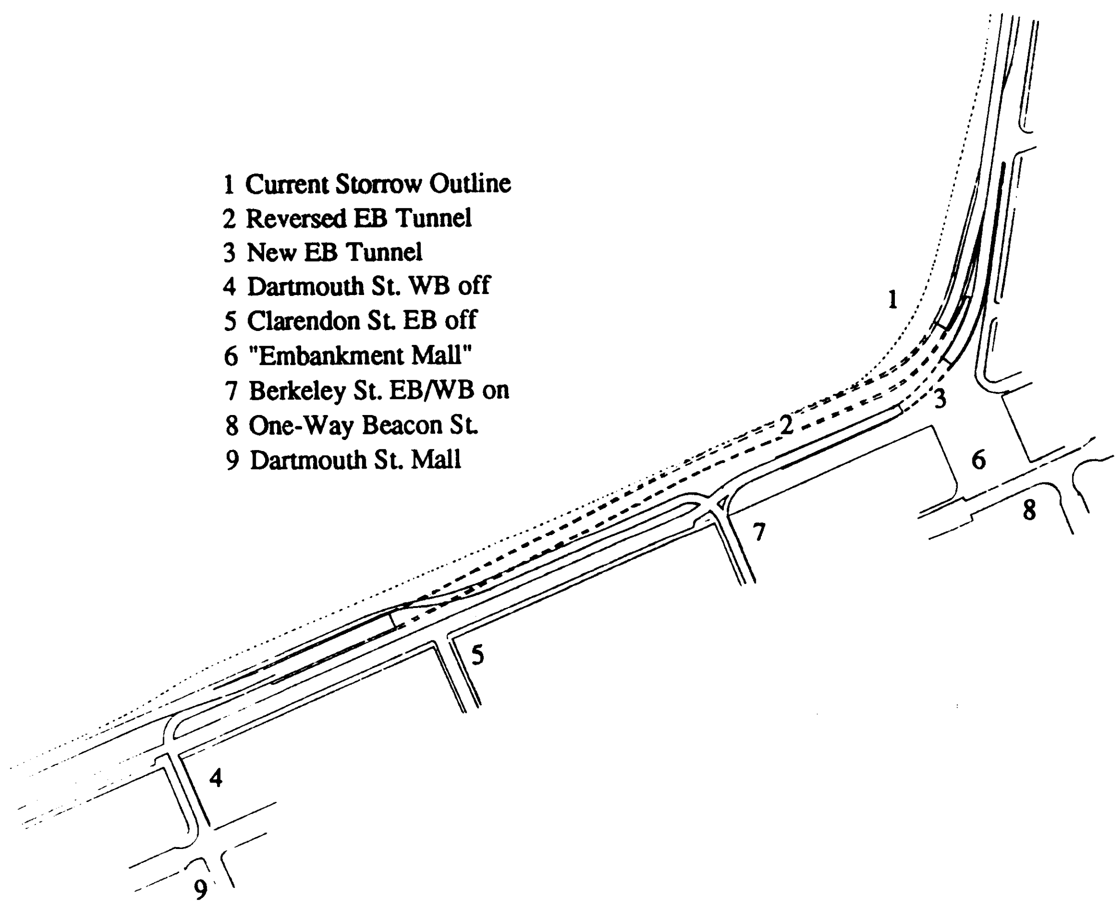


Figure 3.3-1. Redesign Option for Arlington/Berkeley Ramp Area With Reverse Tunnel.

With this design, eastbound traffic would run along an alignment just to the north of Back Street — currently in part occupied by the Clarendon Street off-ramp — between Dartmouth and Berkeley Streets. The westbound off-ramp from Storrow Drive would be shifted to Dartmouth Street which, in turn, would need to be reversed in direction between Beacon Street and Commonwealth Avenue. Alternatively, the westbound off-ramp could be maintained at Arlington Street, to the detriment of a pedestrian connection as will be described below. The eastbound off-ramp at Arlington Street would be closed and all of the westbound section of Storrow Drive between Mt. Vernon and Dartmouth Streets could be eliminated. Instead of having high-speed, grade-separated ramps, left turns from Storrow Drive to Darmouth Street and both left and right turns from Berkeley Street to Storrow Drive would be signal-controlled.

Between Dartmouth Street and Massachusetts Avenue, Storrow Drive would run as a regular four-lane arterial with no left turn possibilities. Back Bay surface streets could be connected to Storrow Drive eastbound and several signalized pedestrian crossings established, such as one at Gloucester or Fairfield Street.

At the Harvard Bridge, the two existing underpasses adjacent to Back Street could be maintained but the eastbound Storrow mainline used for westbound traffic. The eastbound Storrow Drive mainline would run on the existing Fenway off-ramp alignment which uses the southern underpass. Both underpasses accommodate two lanes of traffic which would be sufficient if Storrow Drive were downgraded to a four-lane parkway. A sketch plan for one possible option of this section of Storrow Drive is shown in **Figure 3.3-2**. The reconfiguration options of the expressway from the Harvard Bridge West are described in Chapter 3.4.

3.3.2. Open Space

Some of the open space implications of the design shown in **Figure 3.3-1** and variations thereof are substantial. The alternative use of the tunnels could eliminate the outer westbound segment of Storrow Drive and allow a 35- to 45-foot wide strip of land between Mt. Vernon and Dartmouth Street to be returned to the original Esplanade. Where the eastbound Arlington Street off-ramp is closed, the area of the current boat section could also be used for open space.

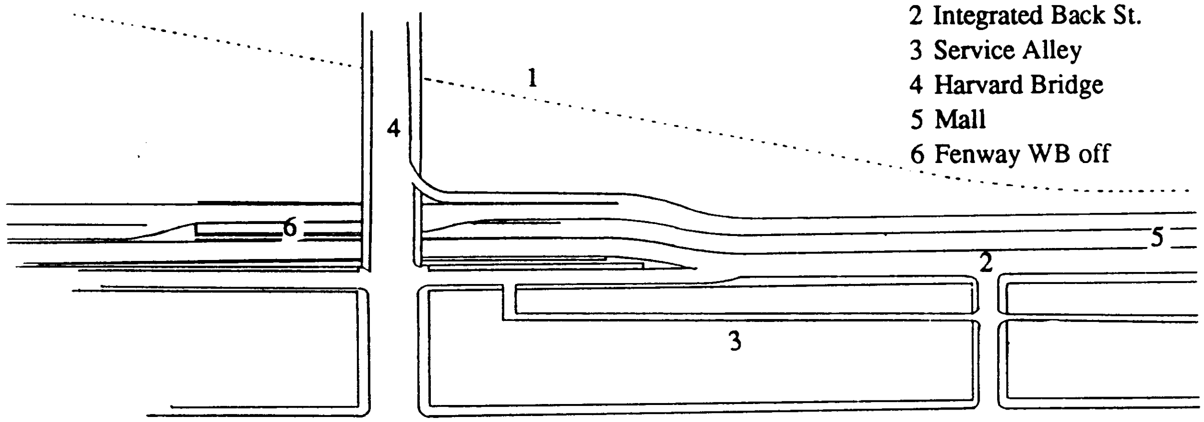


Figure 3.3-2. Redesign Option for Harvard Bridge Underpass and Integrated Back Street.

The greatest possible benefit would occur at the location of the current Arlington off-ramps. With this design option, all ramps would be removed in this location and the corridor opened for free pedestrian movement. Since the eastbound Storrow mainline would use the existing underpass in this location and the Embankment Road on-ramp would be closed — as has been proposed elsewhere[112] — the Esplanade could extend one "arm" into Boston up to Beacon Street. On the other hand, if the westbound Arlington off-ramp were maintained, these open space improvements would be diminished albeit not lost.

Further west, between Dartmouth Street and Massachusetts Avenue, several options are available. Elimination of one westbound lane could be used to widen the Esplanade or to establish a narrow, tree-lined mall. While the integration of Back Street is not a requirement for the feasibility of any of these configurations, the open space gains would be even greater. In this case, as the sketches reflect, the additional space could accommodate optionally a lane of parking, sidewalks, bicycle paths, a tree-lined mall and some additional park space. The inclusion of Back Street, while beneficial from an open space point of view, would have a great impact on transforming the pedestrian environment north of Beacon Street, as will be seen further below.

3.3.3. Pedestrian Circulation

Reusing the tunnels as described above and removing the Embankment Road/Arlington Street ramps would have substantial benefits for pedestrians. A freed up Embankment Road entrance/exit area could accommodate a wide pedestrian mall which would draw the river park into the city. This would help to visually and physically connect the Esplanade to the city. Thus, a continuous connection between the Public Garden and the Esplanade, interrupted only by Beacon Street, would be created, as shown in **Figure 3.3-1**. In addition, with no more eastbound movements on Beacon Street, this would allow its narrowing from currently five total to three westbound lanes in the vicinity of this intersection and simplify crossing technically and psychologically. Furthermore, it would open up the potential to downgrade Arlington Street with two fewer lanes feeding into it. This, as a spin-off effect, could help connect the Back Bay and Commonwealth Avenue to the Public Garden.

As was seen in **Figure 3.3-1**, under this option Dartmouth Street would replace Arlington Street as the major off-ramp for westbound Storrow Drive traffic. Its pedestrian mall, which currently ends at Beacon Street, could be extended to the Esplanade by combining the two existing narrow sidewalks into one wider one. During the signal phase where vehicles turn left from Storrow Drive into Dartmouth Street, pedestrians would be able to cross at-grade.[113]

An integration of Back Street into the design of Storrow Drive — the version depicted in the main sketch plans — could have a tremendous potential impact on the pedestrian environment in the North of the Back Bay. Initially put forward by architect Edward Nilsson as part of his RiverVision/2020 proposal, several recent designs from the Boston Visions competition of 1988, are proof of renewed interest in rethinking whether the Back Bay should continue to back the Charles. **Figure 3.3-3**[114] shows an exemplary design from the architectural competition and some more examples can be found in the appendix (**Figure 3.3-A1** and **Figure 3.3-A2**). The additional space could be used to create a continuous sidewalk along Storrow Drive. Some kind of boulevard design in the adjacency of the river park could draw thousands of people to the waterfront. This would help to expand the current Back Bay pedestrian realm all the way to the Esplanade and river, a realm which is currently bounded psychologically and physically by Beacon Street in the North.

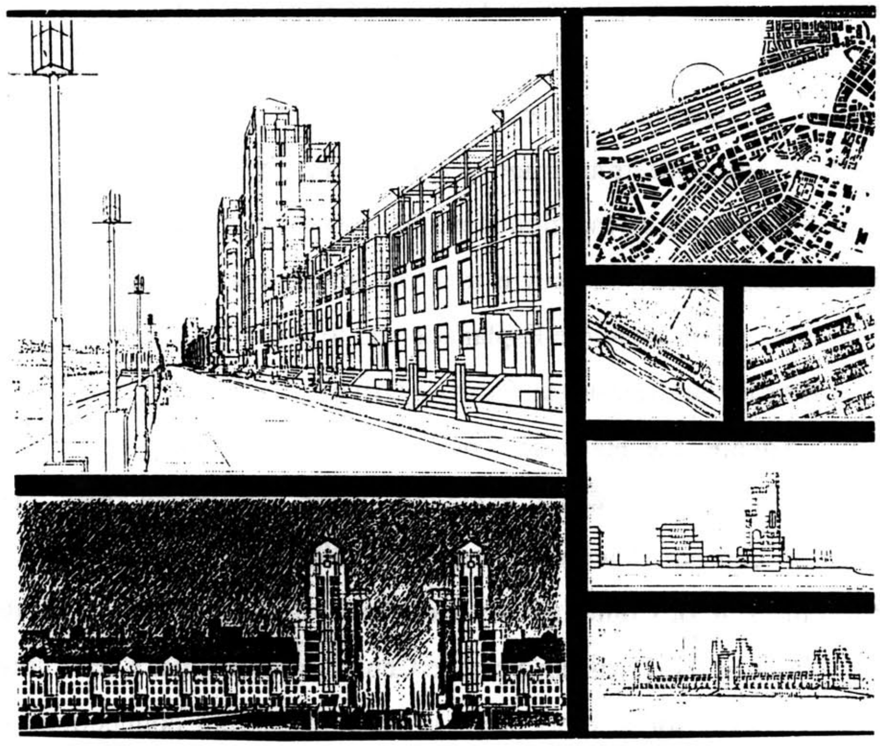


Figure 3.3-3. "Storrow Terrace" Design Option from Boston Visions Competition, 1988.

However, and the mentioned proposals reflect this, a Back Street integration hinges crucially on finding new design options for the backs of North Beacon Street residences. While the sketch in **Figure 3.3-2** shows a new location of an alley just to the back of these houses with parking provided at the level of the current Storrow Drive — about 5 feet below Back Street — it has not been examined whether buildings could be redesigned in such a fashion or whether replacement parking could be provided under this alternative design. However, experience in Brooklyn Heights in New York provides a vivid example of a similar design problem being solved effectively. Clearly, to find answers to the above questions, further study will need to explore these issues in detail.

A further possibility of improving the appeal of Back Street could be to encourage some kinds of activities which could attract people to walk beyond Beacon Street. Not only would this improve safety in this area but it would also, if nothing else should happen, improve the use of the current pedestrian bridges which seem to be planted in a nowhere-land. The goal should be to create access to the Esplanade from the city, not from a dirty and dangerous back alley which too ostentatiously symbolizes the stubbornness of 19th-century aristocrats.

In effect, any pedestrian improvement along the Storrow Drive alignment and pedestrian mall proposals as mentioned above would help to connect Back Bay activity centers with the Esplanade. The key is to allow frequent pedestrian connections from the Back Bay in order re-integrate the Esplanade and to provide some impetus for rethinking Back Street (after having rethought Storrow Drive).

Copley Square, the Hancock Tower and Public Library could access the river using via a Dartmouth Mall which extended all the way to the river. The Prudential Center could be connected with an Exeter or Gloucester Street Mall. Workers and visitors at the Institute of Contemporary Art, the Boston Architectural Center, the Hynes Convention Center or the Christian Science Center, to name just a few, could effectively be drawn to the river for a short stroll if such pedestrian connections existed. The possibilities are innumerable.

3.3.4. Integrative Design and Urban Links

The options for open space enhancements along with pedestrian improvements along the back of Beacon Street would greatly facilitate the integration of the Back Bay and Esplanade. For Beacon Hill, this connection is far easier to achieve since the row of houses facing the river were built to face the river. While attempting to convert the backs of North Beacon Street residences to facing the river might be a considerable design challenge, it has been a recurring theme with architects in the past years.[115]

Another factor contributing to the joining of park and community would be the integration of Storrow Drive into the Back Bay surface street network. As put forward in the options for a downgraded Storrow Drive described in previous sections, making the expressway comparable to other arterials in the Back Bay through signalization and reduced volumes and speeds and thus allowing at-grade pedestrian crossing could transform what is now a boundary to a seam.[116] The Back Bay would grow by a block in its entirety.

Pedestrian crossings at grade would further render pedestrian bridges steel structures of the past. While they are not necessarily considered unsightly in these locations, they are not planted in an environment where pedestrians like to stroll or linger. In thinking about pedestrian connections, the entire walking path must be considered.

Improved design of corridors leading to the park would further aid the establishment of a better visual continuum from the Back Bay to the river. Pedestrian malls, narrow as they may have to be because of the physical constraints imposed by existing buildings, could be a successful design method in bringing people to the park — and the park to the people. In the Back Bay, the opportunities to improve accessibility will multiply once a reduced Storrow Drive can be achieved.

3.4. Charlesgate

Maybe Charlesgate is the most obvious and stunning example of the highway-park conflict in Boston. As pointed out in Chapter 2.3, the Charlesgate interchange and Bowker overpass have literally cast dark shadows on the once beautiful area underneath. This section discusses potential redesigns which could help revert Charlesgate to something closer to what it used to be before the highway construction of the 1950s and 60s.

3.4.1. Redesign Options

I will focus on the discussion of three basic roadway configuration options at Charlesgate. In all three options, the existing massive Charlesgate interchange at Storrow Drive would be removed. Instead, roadway connections would occur at the surface which, in two of the options, would be fully signal-controlled intersections between

Charlesgate and Storrow Drive. In the third configuration option, the Storrow Drive mainline would run underneath the Muddy River. With this design, surface connections could be performed as above but would not necessitate any signalization. In addition, a corridor along Muddy River could provide direct access for pedestrians to the Esplanade without necessitating the crossing of Storrow Drive.

In all three options, Charlesgate East and Charlesgate West would be reconfigured as two-way links to accomodate the turning movements from and to westbound Storrow Drive. These signals, in the first two options, also serve as crossing points for pedestrians from the surface network to the Esplanade.

Under the first option from above, the Fenway connection via the Bowker overpass is replaced by a functionally comparable underground structure, leaving only a pedestrian-sized connection in place, with tunnels designed to either allow all turning movements or a subset of these. The sketch in **Figure 3.4-1** shows a tunnel scheme which maintains three connections but eliminates the Fenway - Storrow Drive eastbound ramp. The removal of this ramp follows the rationale established in Chapter 3.1 where it was stated that downgrading Storrow Drive needs to be coupled with limiting capacity at its entry points. Allowing too much traffic to get onto Storrow Drive would contradict the objectives of a downgrade and could result in severe congestion which would reduce the value of the smaller roadway. Therefore, a capacity constraint should be ideally located at the boundary of the downgraded roadway segment.

This redesign option differs from the original in three other important transportation features: First, the connections of the tunnel with Charlesgate North of the Turnpike are eliminated since the ramps would make these connections in open boatsections adjacent to the Muddy River. This is hardly an improvement to the current condition. Second, Boylston Street is converted to a one-way eastbound street to improve pedestrian connections along its sides and at intersections with the Fenay and Park Drive. Moves from Boylston Street to Storrow Drive can already be similarly performed by vehicles using Massachusetts Avenue and Beacon Streets. Third, the tunnel from Storrow to the Fenway has only one exit on Park Drive and none on Boylston Street east of the Muddy River. This move is eliminated to simplify the tunnel structure and since two alternative routes, small detours, either via a path along Park Drive, Agassiz Street, the Fenway and Boylston Street or, alternatively, via Park Drive, Agassiz Street, Westland Street and Huntington lead into the Back Bay commercial district currently accessed directly via Bowker and Boylston.

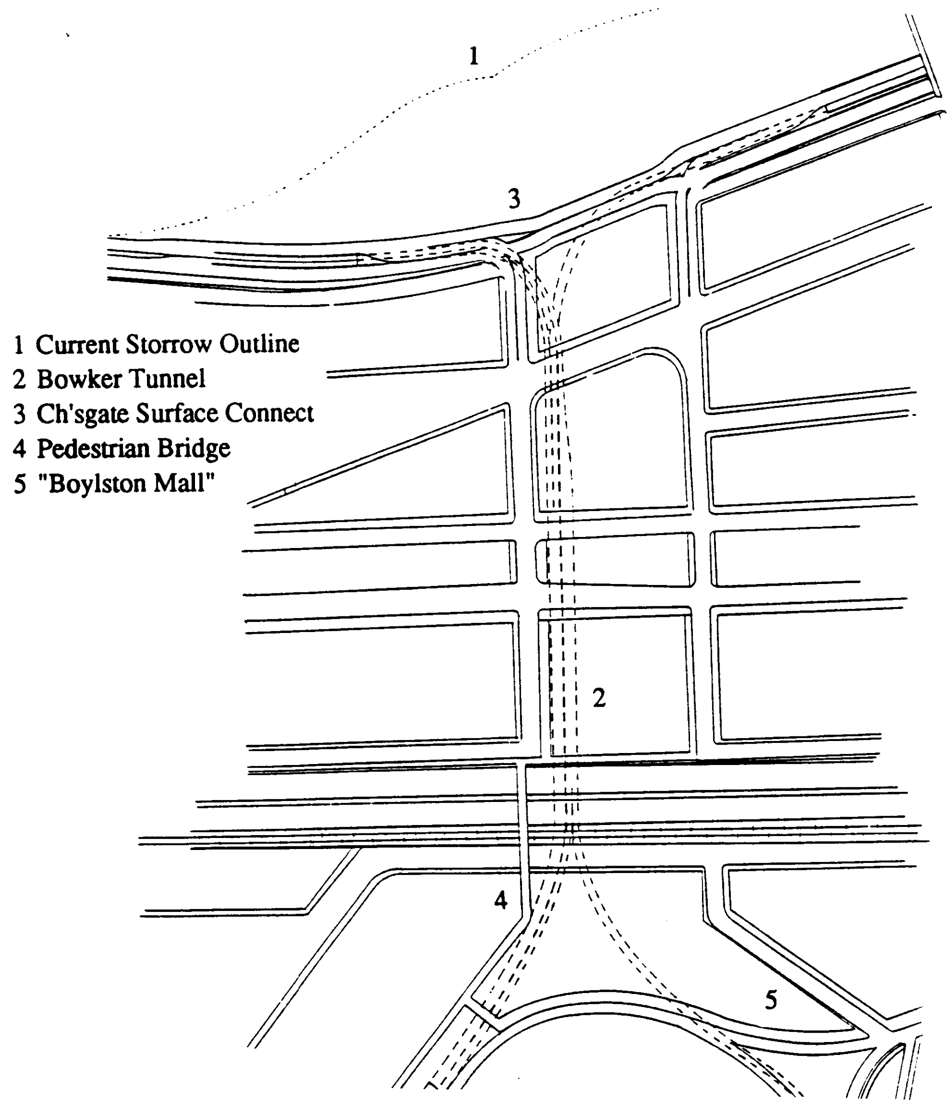


Figure 3.4-1. Redesign Option for Charlesgate with Tunnel Connections.

The second option corresponds to the first in all surface connections but instead of a tunnel, a one-way overpass from Charlesgate West to Park Drive southbound is maintained. Since this half-circle shaped ramp is part of the current Bowker flyover, it will be referred to as the Bowker "wing." Similarly, the third option would utilize such a Fenway connection.

This latter design eliminates most of the existing direct connections between the Fenway and Storrow Drive. Compared to a tunnel option, it is inexpensive and would require no new construction while yielding substantial open space benefits and amenities to pedestrians. In addition, it doesn't preclude a potential depression of the Massachusetts Turnpike in the future.[117]

3.4.2. Open Space

All redesign options discussed above would have substantial benefits in terms of open space. As could be seen in the illustrating sketch of **Figure 3.4-1**, the redesign options would remove the intrusive and space-consuming Charlesgate interchange and eliminate, partially or completely, the Bowker overpass. The gains in open space along the Esplanade would be vast, as would be the improvement of connection between the Esplanade and Kenmore Square area surface streets.

With the designs discussed for the Harvard Bridge underpass and Charles Circle, a final "blocked node" along the Esplanade could be removed, establishing a continuous linkage from the Boston University Bridge in the West to Leverett Circle in the East. With ongoing planning and expected improvements at both ends of this corridor, Allston Landing and the Central Artery's Charles River crossing, the opportunity of extending this park system and establishing a continuous open space and pedestrian link to the sea and Boston waterfront, a century-old dream which has been shattered by pre-existing rail and later added highway facilities across the Charles and its banks, could finally be realized.

At Charlesgate iself, the removal of the Bowker overpass enhances the quality of the open space beneath compared to its current state, as was described in detail in Chapter 2.3. The Muddy River would appear more as an open space when connected to the river park. The reconnection of the Muddy River confluence and Charles River, achievable with both a Storrow bridge and tunnel option, would re-establish and even improve a park connection lost a generation ago.

On the Fenway side, some open space could be gained from the conversion of Boylston street to a one-way eastbound facility. The Bowker/Boylston intersection would be removed and open some parts of the Muddy River to sunlight. In the first option discussed above, the removal of the entire Bowker structure, including the western "wing," would further uncover the original saltmarsh underneath.

3.4.3. Pedestrian Circulation

Typically, open space enhancements and improved pedestrian circulation go hand in hand as the creation of non-vehicular environments facilitates the free passage of pedestrians along certain corridors.

The scrapping of the Charlesgate interchange has the single-greatest positive effect in creating pedestrian accessibility to the Esplanade in all configurations considered. The new link, established through open space, pedestrian and visual re-connection, facilitiates movements from the Fenway/Kenmore Square area along the Muddy River to the Esplanade, as well as along the Esplanade.

This linkage, currently obliterated by the interchange, could draw people from the neighborhoods to the waterfront and greatly improve the vitality of the entire district. As was the case in the Back Bay, today the pedestrian realm is limited by Beacon Street on the North. "Pulling the plug" at Charlesgate would not only improve pedestrian activity in the immediate vicinity of the Muddy River confluence, but could promote walking along the Fenway as well. With the removal of the Bowker overpass in this corridor, the magnificant view of the Esplanade from the Boylston Bridge will make the re-connection felt even at a greater distance from the river. This, in turn, could establish new pedestrian paths from the neighborhoods abutting the Back Bay Fens to the South.

Along Boylston Street, the establishment of a pedestrian mall could further draw people from areas at the western periphary of the Back Bay, such as the Hynes Convention and Christian Science Center to the Fens and Charles River. A direct connection from Massachusetts Avenue with minimal vehicle interference could be afforded by such a design, especially since most of the original intersections with major vehicular-pedestrian conflicts are eliminated as a consequence of the one-way street conversion.

The impetus generated by the establishment of a vital connection to the Charles River could spread way beyond Charlesgate. One important implication mentioned above is that such an improvement could promote the connection of the Charles River to Boston Harbor by extending the length of contiguous open spaces along the river. A second possible consequence of the new design could be the development of a coherent pedestrian network propagating from the Fenway. In a similar way that the downgrading of Storrow Drive could strengthen pedestrian North-South corridors in the Back Bay, the redesign of the Charlesgate/Fenway connection could lead to the development of new pedestrian linkages between currently disparate elements in the urban system.

3.4.4. Integrative Design and Urban Links

The envisioned open space and pedestrian connections described above can lead to, and be augmented by, improvements in the abutting environment. Some examples of concurrent developments which could benefit or benefit from the Charlestgate improvements discussed above are the following:

First, on-going air-rights feasibility studies over the Massachusetts Turnpike could lead to create a continuum between Kenmore Square, Fenway Park, the Fens, Muddy River and districts to the east. Thus the open corridor created at Charlesgate which also helps to eliminate the barrier between the Back Bay and Kenmore area could be complemented by air-rights developments which would better connect the northern and southern portions of neighborhoods in its proximity.

Second, the possible addition of Turnpike ramps in the Kenmore Square area and development of a major transit node at this location could be linked to Kenmore Square traffic circulation improvements and a more pedestrian-oriented environment in its vicinity. As envisioned in some joint Turnpike ramps/air-rights development studies, the promotion of pedestrian activity at the surface level is a major element of these plans. Linked to improved accessibility to the Esplanade at Charlesgate, strong pedestrian linkages between these neighboring locations could be established.

Third, the vision of installing a water "vaporetti" transportation system could help connect communities, such as Allston, which currently removed from many of the open space amenities of the Charles River lower basin. The opening of the Muddy River has also been seen as an opportunity to extend this vaporetti system into the Fens and connect important activity centers along the Muddy River, such as the Longwood Medical Area, Museum of Fine Arts, Conservatory of Music and Fenway Park.

Fourth, the construction of a possible commuter rail stop at Ipswich Street would improve transit access and generate additional pedestrian activity in the area. This could help to further humanize traffic and lead to the development of a more pedestrian-oriented environment.

Fifth, new linkages could be established to the soon-to-be-completed Olmsted Plaza with improved pedestrian connections along Brookline Street, as well as to the Southwest Corridor Linear Park along Ruggles Street where major construction is expected in the near future.

The construction of a circumferential transit line could further enhance the accessibility of this area by public transportation and by foot. The superior transit connections and pedestrian-friendly environments afforded through this and the above developments all help to increase the vitality of this area and relinquish the accessibility and circulation monopoly of the automobile in the existing park system.

This chapter has explored possible ways to improve the accessibility of the Esplanade from the Back Bay and Beacon Hill and discussed some of the opportunities to improve the quality of the urban environment in its adjacency through the revitalization of open spaces, the promotion of pedestrian activity, an expansion of the use of public transportation and an improvement of urban linkages through design measures. It could be seen that there are a great number of opportunities to restore and improve urban vitality along all of these dimensions at selected locations where currently transportation facilities interfere with the above objectives. The next Chapter will deal explicitly with the transportation components of these plans.

Chapter 4
Transportation Impacts

The various design options explored in Chapter 3 for the three focal areas represent a brainstorming of selected ideas on how to improve access to the Esplanade. While the urban design implications of these options were discussed in more or less detail, the transportation implications were not. An estimation of these is the object of this chapter.

4.1. Systems Relationships

In order to organize the multiple transportation elements of options put forward in Chapter 3.2-3.4, it is necessary to show the interdependences between option elements. The extent to which the application of one option element is tied to the achievement of another reveals the systems relationship between the two. The object of this chapter is to classify option elements according to several characteristics and then to highlight the above relationships in oder to *develop downgrading schemes* which can then be used for the traffic analysis in the following chapter.

In **Table 4.1-1** the explored options are classified according to several characteristics. The first identifies their approximate construction or implementation cost. For the purpose of this analysis it is sufficient to distinguish between large, medium and small costs. A L(arge) in the table refers to design components which require major construction or would cause significant disruption during the period where it is implemented whereas a S(mall) indicates that the action would only require minor modifications of the existing design. The second indicator classifies options according to their transportation impact where a L(arge) impact means substantial changes in capacity or connectivity, resulting in changes of travel paths through re-routing. The variable in the third column, Systems Linkage, indicates whether the proposed action is tied to another either because of engineering requirements (E) or because of the systems logic (S). An engineering requirement would be, for instance, that an existing tunnel can only accommodate a certain number of lanes while a systems requirement is that a shift of the westbound off-ramp on Storrow Drive from Arlington to Dartmouth Street would logically imply that traffic signals be installed at Berkeley and Dartmouth Streets. As a result, this information conveys an understanding of which design modifications could be performed independently and which ones could not from a system point of view.

#	Proposed Component	Implement. Cost	Transp. Impact	Systems Linkage	No Action	Schemes		
						LOW	MED	FULL
1	**Charles Circle Redesign**	**M-L**	**S**	**None**	**No**	**Yes**	**Yes**	**Yes**
2	Mainline Tunnel under CC	M-L	S	None	|	|	|	|
3	Reconfigured CC	S	S	S1	|	|	|	|
4	Removal of CC viaducts	S-M	S	S1	|	|	|	|
5	Removal of EEI parking lot	S-M	S	S1	|	|	|	|
6	Widened Sidewalks	S	S	S1	|	|	|	|
7	Pedestrian Crossings	S	S	S1	|	|	|	|
8	**Embankment Rd Area Redesigr**	**S-M**	**L**	**E34,E35**	**No**	**No**	**Yes**	**Yes**
9	Replace Arl by Dartm ramps	S-M	M-L	S8	|	|	|	|
10	Reversal of Dartmouth	S	M	S8	|	|	|	|
11	Alternative use of tunnels	S	M-L	E8,E36,E37	|	|	|	|
12	Removal of Arlington ramps	S-M	M-L	S8,S37	|	|	|	|
13	Beacon 1-way @ Embankment	S	M	S8	|	|	|	|
14	B and C ramp alterations	S-M	M-L	E8	|	|	|	|
15	Signal Controls at B and D	S-M	L	S8	|	|	|	|
16	Embankment Mall	S-M	S	E8	|	|	|	|
17	Removal of outer WB Storrow	S-M	L	E8	|	|	|	|
18	**Back Bay Options**	**S-L**	**S-L**	**S8**	**No**	**Partial**	**Partial**	**Full**
19	Traffic Signalization	S-M	L	S8,S36,S37	|	No	Some	Yes
20	Pedestrian at-grade crossing	S-M	L	S8,S19	|	No	Some	Yes
21	Integration of Back Street	L	S-M	S8,S18	|	Optional	Optional	Optional
22	Redesign of N Beacon houses	L	S	E21,S18	|	Optional	Optional	Optional
23	Use of Mass Ave underpasses	S	S	E36	|	Yes	Yes	Yes
24	Connection to Surface Roads	M	S-M	E21,S22	|	Yes	Yes	Yes
25	All Tunnel	L	S	S1	|	No	No	No
26	**Charlesgate Redesign**	**M-L**	**S-L**	**None**	**No**	**Full Tunnel**	**Part Tunnel**	**No Tunnel**
27	Removal of Bowker overpass	M	L	None	|	Yes	Yes	Yes
28	SB Bowker "Wing"	S	M	S27	|	No	No	Yes
29	Replacement by tunnels	L	S-M	S28	|	Yes	Yes	No
30	Removal of Fwy-St EB ramp	S-M	M-L	S26,S37	|	No	Yes	Yes
31	Signals at surface connections	S-M	L	S27	|	Only EB	Yes	Optional
32	Boylston one-way EB	S-M	M	None	|	Yes	Yes	Yes
33	Extension of Tunnels E of Mass Ave	L	S	S26	|	Yes	No	No
34	Storrow Tunnel Under Muddy River	L	S	E27,S28	|	No	No	Yes
35	**System Redesign**	**S-M**	**L**	**S8,S19**	**No**	**Low DG**	**Med DG**	**Full DG**
36	Speed Limit 30mph	S	L	S8,S37	|	No	Yes	Yes
37	Reduction to 2 lanes	M	L	S8,S36	|	No	Yes	Yes
38	Preferential signal phasing	S	M	S8,S19,S36	|	No	Yes	No

Figure 4.1-1. Overview of Selected Options for Downgrading Storrow Drive.

A systems approach implies that design modifications are combined in a manner such that all component changes complement each other. If the formulated objective is to connect the Esplanade to the Back Bay by cutting volumes on Storrow Drive in half, this will necessitate not only the downgrading of Storrow Drive through removal of lanes or signalization but also the limitation of capacity at entry points to the local system, the study area, and the development of some urban design improvements which would translate a capacity reduction into amenities for pedestrians or enhancement of open space. A $150 million investment in fancy tunnels under Charlesgate might not necessarily be wise from a systems point of view. It might facilitate high-volume access to Storrow Drive which could increase traffic on the envisioned downgraded roadway to an extent such as to limit the pedestrian accessibility which had initially motivated the redesign. This implies that configurations of key nodes along the Storrow alignment[118] must be coordinated with each other and reflect the role Storrow Drive is envisioned to play in the future under the formulated downgrading objective. This is what I mean by a systems approach.

In order to provide a menu of options, I have developed design modification packages, referred to as *schemes*, which relate a formulated objective, simply stated as the degree of desired downgrading, to the examined design components which would be linked to its implementation. This list is by no means exhaustive but should serve as a guide to understanding the relationship between the multiple elements of a downgrading or a no action plan.

The following scheme options utilize the information on component "co-dependence" to develop a package of actions in accordance with a specified downgrading objective.

The first scheme (NO ACTION) is the base case, which assumes that no changes are undertaken by 2010. This scheme is referred to as *Scenario 2010* in our model.

The second (LOW SCHEME) is a slight downgrade option in which the Bowker overpass would be replaced by an equivalent tunnel scheme. This corresponds to one variation of option one in the discussion of redesign options at Charlesgate in Section 3.4 and replacement of all ramps in tunnels — with the exception of the two ramps from the

Charlesgate surface streets to the overpass/tunnel. At Charlesgate, signals would control surface movements only for eastbound vehicles on Storrow Drive. Storrow Drive would be redesigned at the Harvard Bridge and at Charles Circle like the other downgrade options and as depicted in **Figure 3.2-1** and **Figure 3.3-2**. No changes would occur in the Arlington/Berkeley Ramp Area and the mainline would remain three lanes wide as in its current configuration. This scheme is referred to as *Scenario 3011* in the model.

The MED SCHEME is a moderate downgrade scheme which, in addition to tunneling links at Charlesgate, would eliminate the Fenway-Storrow Drive eastbound ramp as depicted in **Figure 3.4-1**. It would use the tunnel redesign in the Arlington/Berkeley Ramp Area as discussed in Chapter 3.3. Storrow Drive's capacity would be reduced by about 50% through the elimination of the third lane, a speed limit of 30 mph and signals at Charlesgate, Gloucester/Fairfield, Dartmouth, Berkeley and Pinckney Streets.[119] Preferential signal phasing during rush hours and times of low pedestrian activity, however, would leave its capacity above that of normal major arterials. This scheme is used for most of the analysis of transportation impacts in this chapter and is called *Scenario 3012* in the model analysis.

The FULL SCHEME is the most radical downgrade option where the Bowker overpass would be removed leaving only the Bowker "wing," as described in options 2 and 3 in Chapter 3.4 but have no direct links beyond the surface connections between Storrow Drive and the Fenway/Park Drive.[120] Storrow Drive's capacity is reduced to one comparable to Commonwealth Avenue. A lower speed limit, 25 mph, and a signal phasing system which gives greater preference to pedestrians are its key distinctive features compared to the intermediate downgrading scheme. All other elements are identical to the MED SCHEME. This scheme is referred to as *Scenario 3013* in the traffic model.

All downgrading schemes have the Charles Circle redesign — the LOW SCHEME with a total of 5 underpass lanes — and Harvard Bridge underpass utilization in common, as were shown in **Figure 3.2-1** and **Figure 3.3-3**. Furthermore, conversion of Boylston Street to a one-way facility is part of all these three schemes. In the following section, these network changes are described in more detail.

4.2. Network Representation

In order to estimate traffic impacts of the various options put forward in the preceding section, the physical changes are simulated in the model network. Connectivity and geometric relationships in the system, link capacities and free flow speeds are adjusted to account for the changes under consideration. The remodeled network will then serve as the basis for running a set of new traffic assignments which reflect the redistribution of trips as a consequence of the modifications in connectivity and roadway configuration.

4.2.1. Estimation of Capacities and Free Flow Speeds

The *Highway Capacity Manual* is the most detailed source for capacity calculations based on certain features of the roadway and intersections. Incorporating variables such as geometric design, pedestrian volumes, length of turning lanes, signal phasing and coordination, platoon characterisitcs, parking frequency and others to calculate intersection capacities which in turn determines the capacity of the roadway segments framed by them, it is a tool which can achieve a very accurate capacity estimate if data are available.

For the purpose of analysis in this paper, however, this method is not only cumbersome but also impractical. A traffic modeling package such as EMME/2 is a tool to measure macroscopic rather than microscopic distributions and changes in the network. As could be seen in Chapter 1.2, assigned volumes for specific links can deviate more than 100% from actual traffic counts. Introducing a "bottom-up" approach to estimate capacity impacts of a different configuration in a small segment of the network in conjunction with the "top-down" method of the modeling software would therefore be inappropriate. A top-down approach implies that roadway features are aggregated and averaged rather than each link's speed and capacity charactristics being calculated individually. The coded link characteristics in the network from CTPS reflect this top-down approach. Rather than coding each link according to its specific impedance, denoting the facility with which a link can be traversed, a link is classified as a specific type. This means that a local street can carry, say, about 500-600 vehicles per lane at a speed between 7 and 12 miles, depending on factors such as the distance between intersections and parking frequency. Similarly, minor and major arterials with a specific set of characteristics are assigned to a particular class of roadways.

While a disaggregate analysis of capacity implications of a particular configuration change could be a next step to more accurately assess the true impedance characteristics of reconfigured links and connections under various design option assumptions, this is not the object of this paper. Rather, I attempt to give a general idea of the *magnitude of change* to be expected from tampering with Storrow Drive. Capacity and free flow speed estimates for this purpose are based on the following set of simple rules:

1. by default, identical capacities and free flow speeds as in the base case are assumed unless there is a significant change to the link under consideration,
2. signals, parking and turning movements all reduce capacity to various degrees,
3. capacity is proportional to the length of green time for the roadway.

4.2.2. Application to Scheme Options

Based on these rules and a set of simplifying assumptions, capacity calculations for Storrow Drive were performed using a rule of thumb technique which give the following estimates for total hourly capacities on Storrow Drive:

NO ACTION	3 lanes, no signals, no parking	C = **5,100** EB and WB
LOW SCHEME	3 lanes, no signals[121], no parking	C = **5,100** EB (partial) and WB
	3 lanes, signals[122], no parking	$C \approx$ **3,300** EB (partial)
MED SCHEME	2 lanes, signals, parking (EB)	$C \approx$ **2,000** EB, $C \approx$ **2,200** WB
FULL SCHEME	2 lanes, signals, parking (EB)	$C \approx$ **1,500** EB, $C \approx$ **1,600** WB

While a capacity of 1,000 or 1,100 vehicles per lane is higher than the average 750-900 for a major arterial, it seems not unreasonable considering that Memorial Drive in Cambridge at its western end where it is signalized has capacities of 950-1000 vehicles per lane. With possible preferential signal phasing envisioned for Storrow Drive during peak hours, these or higher capacities could be achieved. Nevertheless, future research could address this question at a greater level of detail in order to more accurately asses the capacity implications of downgrading Storrow Drive.[123]

4.3. Traffic Volumes

While some changes, such as the reconfiguration of Charles Circle and the tunneling of Charlesgate connections are designed with the presumption of having only minor impacts on traffic flows and speeds, narrowing and signalization will have substantial impacts on the number of vehicles which would continue to use Storrow Drive under a new configuration. In this chapter the impacts are measured numerically and depicted graphically to illustrate the shifts in travel paths from the 2010 base case.

4.3.1. Subregion

To illustrate changes in the distribution of traffic due to the realization of downgrading options in the study area, a format similar to the one established in Chapter 1.2 is adopted. Analysis focusses on the comparison of the MED SCHEME, Scenario 3012 in the model, with the 2010 base case (Scenario 2010). Unless indicated otherwise, this option is referred to as *the* downgrade scenario, while the LOW SCHEME (Scenario 3011) and FULL SCHEME (Scenario 3013) options are discussed in less detail.

Table 4.3-1 shows comparative volumes at peripheral spot locations, which are near "decision points" in the model network, for all three downgrading schemes. It can be seen that the variance between the LOW SCHEME (Scenario 3011) and the base case (Scenario 2010) is relatively small due to the fact that the former design involves few changes to the system and has little bearing on route choices at the periphery of the model network. For the subregional analysis, therefore, it will be sufficient to distinguish between the MED SCHEME, approximating volumes with the FULL SCHEME, and the base case, approximating volumes with the LOW SCHEME.

	LINK	Base 2010	Downgrading Schemes LOW	MED	FULL
Southeast					
Morrissey Blvd N of Dudley St					
Northbound	2798-3805	29,400	25,053	23,967	27,328
Southbound	3804-3005	27,140	28,190	26,958	25,803
Total		56,540	53,243	50,925	53,131
I-93 S of Mass Ave exit					
Northbound	1702-1704	108,313	112,081	113,023	109,957
Southbound	1715-1716	111,079	109,839	111,552	111,985
Total		219,392	221,920	224,575	221,942
Seaver St N of Blue Hill Ave					
Northbound	3029-1641	15,741	15,707	15,773	15,135
Southbound	1641-3029	15,814	15,645	15,726	15,834
Total		31,555	31,352	31,499	30,969
Southwest					
Huntington Ave E of Jamaicaway					
Eastbound	2717-2716	21,584	21,504	21,619	21,012
Westbound	2716-2717	21,554	18,213	18,888	19,044
Total		43,138	39,717	40,507	40,056
Jamaicaway N of Huntington					
Northbound	2718-2725	20,859	20,384	19,349	18,970
Southbound	2725-2718	20,213	20,156	18,975	18,354
Total		41,072	40,540	38,324	37,324
Beacon St E of Harvard Ave					
Eastbound	5316-5314	12,596	11,115	11,119	10,291
Westbound	5314-5316	10,316	9,372	9,198	9,658
Total		22,912	20,487	20,317	19,949
West					
Turnpike E of Beacon Park					
Eastbound	5484-5485	80,277	81,025	84,130	85,663
Westbound	5486-5483	76,658	76,359	80,543	82,661
Total		156,935	157,384	164,673	168,324
Soldiers Field Road S of Western Ave Bridge					
Eastbound	5416-5417	27,249	26,339	25,512	23,219
Westbound	1824-1825	23,560	23,940	22,800	17,702
Total		50,809	50,279	48,312	40,921
Memorial Drive E of L. Anderson Bridge					
Eastbound	4414-4415	5,620	5,902	5,265	5,737
Westbound	4415-4414	9,283	8,909	7,636	8,925
Total		14,903	14,811	12,901	14,662
Mass Ave N of Waterhouse St					
Northbound	4387-4388	18,721	18,628	19,288	19,279
Southbound	4388-4387	17,990	17,921	18,409	18,543
Total		36,711	36,549	37,697	37,822

	LINK	Base 2010	Downgrading Schemes LOW	MED	FULL
Northwest					
Somerville Ave E of Porter Square					
Eastbound	4389-3519	12,445	12,408	11,784	11,997
Westbound	3519-4389	11,331	11,527	11,793	11,348
Total		23,776	23,935	23,577	23,345
McGrath Hwy @ Washington St Overpass					
Northbound	5258-5245	19,185	18,996	20,889	20,107
Southbound	5246-5259	16,211	16,483	17,149	17,292
Total		35,396	35,479	38,038	37,399
O'Brien Hwy. W of 2nd St					
Northbound	5264-3543	27,639	27,861	28,338	28,585
Southbound	3542-5265	24,658	23,876	25,478	25,408
Total		52,297	51,737	53,816	53,993
I-93 S of Sullivan Square					
Northbound	5174-5176	99,064	97,886	95,291	97,052
Southbound	5175-5173	104,754	106,124	105,749	105,162
Total		203,818	204,010	201,040	202,214
Sullivan Square Overpass					
Northbound	3459-3461	11,933	11,980	11,878	11,267
Southbound	3462-3460	14,606	14,746	14,063	13,632
Total		26,539	26,726	25,941	24,899
Northeast					
Tobin Bridge (Route 1 North)					
Northbound	1840-1841	68,906	68,382	67,426	67,219
Southbound	1652-1839	63,968	63,949	63,396	63,006
Total		132,874	132,331	130,822	130,225
Route 1A @ Boston Revere Line					
Northbound	3791-3787	33,966	34,083	33,629	34,066
Southbound	4756-3790	34,830	34,747	33,475	33,416
Total		68,796	68,830	67,104	67,482

Table 4.3-1. 2010 AWDT Volumes at Peripheral Spot Locations: Downgrading Schemes.

Figure 4.3-1 shows 2010 traffic volumes with a downgraded Storrow Drive on facilities carrying over 500 AWDT vehicles in the subregion outside of the extended core area. To help visualize the location of large volume shifts, increases compared to the 2010 base case are shown in grey (broken) and decreases in black (solid).

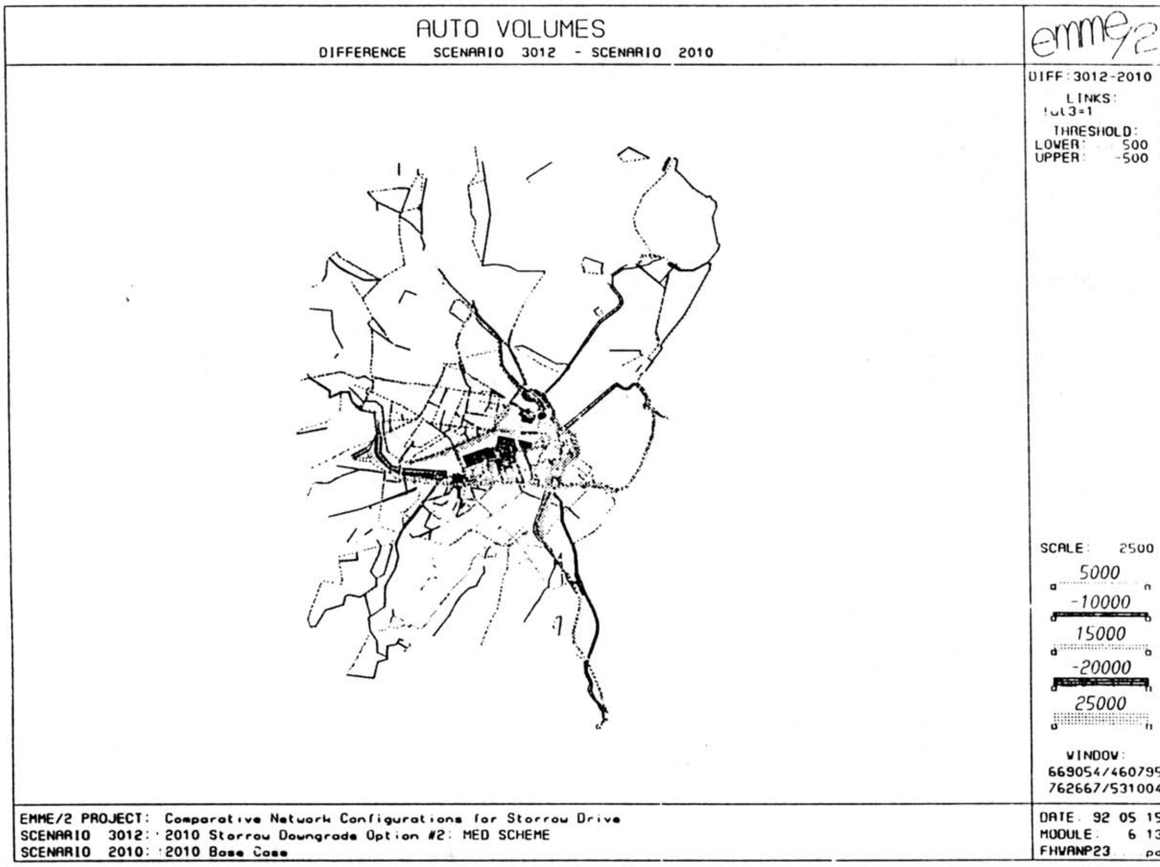


Figure 4.3-1. 2010 Subregion AWDT Volume Comparison: MED SCHEME - Base Case.

In general, as can be seen from both **Table 4.3-1** and **Figure 4.3-1**, few large shifts occur at peripheral locations for the MED SCHEME. This is so because the further removed from the study area, the fewer vehicles are actually affected by the changes, and the smaller the probability that a vehicle would change its path since there are fewer convenient alternative routes. Some notable exceptions to this observation are listed below:

- Increases in volumes in the Third Harbor Tunnel due to the higher utilization of the Turnpike,
- A reduction in traffic using Route 16 eastbound between Routes 1 and 1A possibly as a result of people using the Turnpike-THT-Route 1A connection rather than the Storrow-I-93-Route 1 connection,

- Decreases in northbound volumes on Morrissey Boulevard possibly as a consequence of a lower attractiveness of the Morrissey-Berkeley-Storrow travel path,
- Slight increases in volumes on arterials in northwest Somerville due to the reduced number of vehicles accessing I-93 from Storrow Drive at Leverett Circle,
- Small increases on arterials at the northwestern periphery which feed into Cambridge arterials due to a shift from Storrow Drive to Cambridge arterials,
- Decreases on parkway volumes such as Jamaicaway and Fenway which connect to Storrow Drive at Charlesgate due to the elimination of the Fenway-Storrow eastbound ramp and on Beacon Street west of Kenmore Square due to the lower capacity of Storrow Drive,
- Commensurate increases on arterials such as Blue Hill Avenue and Washington Street which absorb the decreases in volumes on the parkways and on a section of the Riverway north of Route 9.

To examine shifts of vehicle passage through a specified corridor as well as shifts between corridors, the screenline method discussed in Chapter 2.2 is applied in **Table 4.3-A1** (in the appendix). The summarizing screen"ring" volume comparisons are shown in **Table 4.3-2** indicating that under the intermediate downgrading scheme (MED SCHEME) about 25,000 fewer vehicles pass through the central area of Boston. This is a direct consequence of a Storrow Drive being used by fewer vehicles as a regional highway connection.

4.3.2. Extended Core

The redistribution of trips within the extended core area is more visible. **Figure 4.3-2** is the extended core area equivalent to **Figure 4.3-1**. Comparative plots, i.e. plots which compare volumes of one scenario, typically a downgrading option, with another, typically the base case, have "holes" in the focus locations along Storrow Drive and at Charlesgate. Since links were manipulated and new nodes introduced as part of the network representation of a downgrading design, link volumes for these locations cannot

	LINK	2010	LOW	MED DGS	FULL
Screenline West (Mass Ave)					
Albany St E of Mass Ave					
Eastbound	2432-3133	5,465	5,182	6,588	5,623
Westbound	3133-2432	5,384	4,163	5,523	5,386
Total		10,849	9,345	12,111	11,009
Harrison Ave E of Mass Ave					
Eastbound	2431-2430	4,166	4,079	4,034	4,219
Westbound	2430-2431	6,414	6,181	6,414	6,559
Total		10,580	10,260	10,448	10,778
Washington St E of Mass Ave					
Eastbound	2429-3151	3,908	3,639	4,102	4,052
Westbound	3151-2429	2,317	2,246	2,550	2,742
Total		6,225	5,885	6,652	6,794
Shawmut St E of Mass Ave					
Westbound	2427-2428	1,128	1,080	1,215	1,328
Tremont St E of Mass Ave					
Eastbound	2426-2425	6,538	6,178	6,260	6,561
Westbound	2425-2426	8,457	8,332	9,590	9,781
Total		14,995	14,510	15,850	16,342
Columbus Ave E of Mass Ave					
Eastbound	2424-2370	8,551	8,258	8,760	8,263
Westbound	2370-2424	8,188	8,599	8,551	8,307
Total		16,739	16,857	17,311	16,570
Huntington St E of Mass Ave					
Eastbound	2423-2290	12,648	12,054	13,048	15,444
Westbound	2290-2423	15,353	17,061	18,974	18,544
Total		28,001	29,115	32,022	33,988
Belvedere St E of Mass Ave					
Westbound	2293-2421	2,330	2,467	1,727	1,141
Boylston St E of Mass Ave					
Eastbound	2420-2245	8,300	8,244	12,206	14,320
Westbound	2245-2420	2,537 n/a		n/a	n/a
Total		10,837	8,244	12,206	14,320
Newbury St E of Mass Ave					
Westbound	3234-3236	3,756	3,461	2,942	3,705
Comm Ave E of Mass Ave					
Eastbound Loc	3237-3109	950	771	1,627	1,564
Eastbound Thru	3421-3109	7,065	5,168	8,021	7,896
Westbound Loc	3108-3399	862	895	826	889
Westbound Thru	3108-3238	7,846	9,156	10,936	16,079
Total		16,723	15,990	21,410	26,428
Marlborough St E of Mass Ave					
Eastbound	3401-3400	903	790	857	881
Beacon St E of Mass Ave					
Westbound	3403-3402	5,599	3,584	8,861	11,249
Storrow Drive E of Mass Ave					
Eastbound	3404-2464	58,014	38,039	24,563	18,195
Westbound	2463-3065	60,664	62,129	32,606	20,929
Total		118,678	100,168	57,169	39,124
Turnpike E of Mass Ave					
Eastbound	5488-3425	80,277	81,025	84,130	85,663
Westbound	2408-2409	72,728	72,602	78,017	79,484
Total		153,005	153,627	162,147	165,147
TOTAL EASTBOUND		196,785	173,427	174,196	172,681
TOTAL WESTBOUND		203,563	201,956	188,732	186,123
Screenline North (Charles River)					
Longfellow Bridge					
Northbound	2160-2161	16,671	17,617	21,020	21,724
Southbound	2162-2163	16,963	18,671	23,431	24,774
Total		33,634	36,288	44,451	46,498
Charles River Dam					
Northbound	2135-2136	27,674	27,365	26,495	27,304
Southbound	2137-2138	32,430	31,580	30,556	31,584
Total		60,104	58,945	57,051	58,888

	LINK	2010	LOW	MED DGS	FULL
Screenline North (continued)					
Artery Bridge					
Northbound	2113-1834	133,561	132,807	136,595	138,048
Southbound	1833-2116	140,087	138,353	140,038	140,849
Total		273,648	271,160	276,633	278,897
"Leverett Bridge"					
Northbound	6251-6447	73,685	70,891	58,918	58,601
Southbound	6444-6445	74,846	74,583	71,170	67,565
Total		148,531	145,474	130,088	126,166
Charlestown Bridge					
Northbound	3395-3396	32,282	31,779	33,206	33,521
Southbound	3397-3398	26,713	26,531	25,956	25,927
Total		58,995	58,310	59,162	59,448
TOTAL NORTHBOUND		283,873	280,459	276,234	279,198
TOTAL SOUTHBOUND		291,039	289,718	291,151	290,699
Screenline East (Boston Harbor)					
Callahan Tunnel					
Eastbound	5499-5496	43,043	42,557	41,093	40,912
Sumner Tunnel					
Westbound	5497-5498	44,819	44,697	43,658	43,484
Total		87,862	87,254	84,751	84,396
Third Harbor Tunnel					
Eastbound	6398-6399	52,090	52,012	55,457	56,155
Westbound	6413-6415	50,217	50,100	51,821	52,475
Total		102,307	50,100	107,278	52,475
TOTAL EASTBOUND		95,133	94,569	96,550	97,067
TOTAL WESTBOUND		95,036	94,797	95,479	95,959
Screenline South (Southampton St)					
William Day Blvd. S of Columbia Rd					
Northbound	4166-4168	3,309	3,174	3,184	3,328
Southbound	4168-4166	2,956	2,965	2,944	2,803
Total		6,265	6,139	6,128	6,131
Old Colony Ave N of Southampton St					
Northbound	4159-4160	22,005	17,782	16,531	19,783
Southbound	4160-4159	15,739	14,086	16,347	15,749
Total		37,744	31,868	32,878	35,532
Boston St N of Southampton St					
Northbound	3599-4143	3,359	3,196	3,317	3,631
Southbound	4143-3599	3,629	3,747	3,677	4,052
Total		6,988	6,943	6,994	7,683
Dorchester Ave N of Southampton St					
Northbound	3599-4139	4,283	3,816	4,194	5,098
Southbound	4139-3599	2,753	2,453	2,683	2,864
Total		7,036	6,269	6,877	7,962
Frontage Rd N of Southampton					
Northbound	3604-3606	8,653	9,127	9,685	8,359
Southbound		28,165	43,325	28,271	28,266
Total		36,818	52,452	37,956	36,625
Southeast Expressway @ Southampton St					
Northbound	2556-2557	118,283	122,184	122,904	121,646
Southbound	2544-2550	109,809	96,403	107,294	109,580
Total		228,092	218,587	230,198	231,226
Melnea Cass Blvd NE of Mass Ave					
Eastbound	2436-1660	27,564	28,025	28,460	29,776
Westbound	1663-2435	27,505	29,126	29,357	28,128
Total		55,069	57,151	57,817	57,904
TOTAL NORTHBOUND		187,456	187,304	188,275	191,621
TOTAL SOUTHBOUND		190,556	192,105	190,573	191,442
Intermediate Ring Screenline Summary					
TOTAL TRIPS IN		675,280	650,449	653,622	655,001
TOTAL TRIPS OUT		677,992	674,520	655,539	656,763

(All volumes include double river crossing for Leverett)

Table 4.3-2. 2010 AWDT Volumes at Intermediate Screen "Ring": Downgrading Schemes.

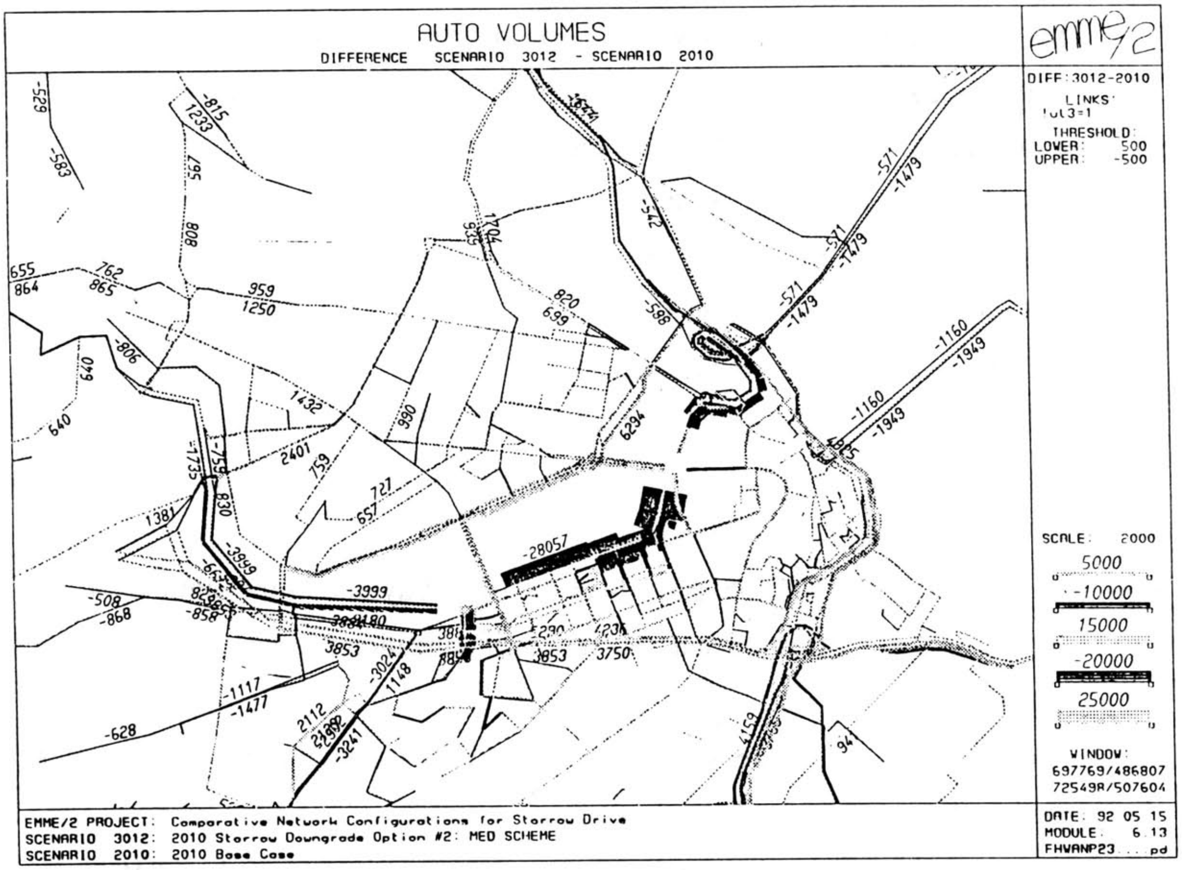


Figure 4.3-2. 2010 Ext. Core AWDT Volume Comparison: MED SCHEME - Base Case.

be directly compared. The plot shows estimated volume differences in excess of 500 vehicles and makes the following shifts evident:

- A massive reduction of Storrow Drive volumes and the feeder ramps from I-93 on the order of 30,000 vehicles in each direction due to its lower design capacity and speeds,
- A visible reduction in traffic on the western Storrow Drive extension, Soldiers Field Road, because of the capacity reduction further east,
- Large increases in travel on Memorial Drive which, because of its location, is the favored alternative route to Storrow Drive,
- Modest volume increases on several Cambridge arterials which serve as substittue travel routes for Soldiers Field Road/Storrow Drive,

- Varying increases on most Charles River crossings due to the higher utilization of Memorial Drive by drivers with Boston origins or destinations and due to the higher utilization of the Turnpike and its feeder arterials at Beacon Park,
- Higher utilization of the Turnpike and Central Artery due to their use as detour routes around the limited-capacity Storrow Drive,
- Generally increases in Back Bay parallel arterials, such as Beacon Street, Commonwealth Avenue and Boylston Street, which are being used as overflow facilities for East-West movements,
- Increases on downtown streets, such as Charles Street north of Beacon, Staniford and Tremont Streets, which serve as access routes to points south of downtown in lieu of the Arlington Street connection,
- Decreases on most North-South arterials in the Back Bay due to the elimination of the Arlington Street off-ramp and higher access utilization from/to the Massachusetts Turnpike,
- Less than commensurate increases on Dartmouth Street, which replaces the Arlington Street off-ramp, north of Commonwealth Avenue,
- Decreases on surface arterials in the Southeast which serve as feeders to Berkeley Street and Storrow Drive,
- Reduced volumes on Commonwealth Avenue west of Kenmore Square which could be linked to the slower connection to Storrow Drive at Charlesgate,
- Reduced volumes in and around the Fenway due to the elimination of the Fenway-Storrow eastbound ramp and the elimination of the westbound Boylston Street segment.

For a more accurate numerical comparison, some of these shifts in traffic distribution over specific links are listed in **Table 4.3-A1** (in the appendix) for screenline locations and in **Table 4.3-3a** for the Central Artery and in **Table 4.3-3b** for the Massachusetts Turnpike. Volume comparisons between the downgrading scheme in specific neighborhoods and areas are shown in **Table 4.3-4a** for Beacon Hill and the Kenmore Square area and in **Table 4.3-4b** for Cambridge and Charlestown below.

		1	2	3	4	5			
	1987 Link	1987 Count	CTPS 1987 Base	EMME/2 1987 Base	EMME/2 2010 Base	EMME/2 MED SCHEME	(5-4) DIFF	(5-4)/4 % DIFF	2010 Link
Central Artery									
Central Artery N of Mass Ave									
Northbound	2526-2558	67,000	83,777	81,563	123,793	128,995	5,202	4.2%	2555-2556
Central Artery S of Albany St									
Southbound	2522-2523	100,500	101,104	102,147	128,513	124,303	-4,210	0	6124-6125
Total		167,500	184,881	183,710	252,306	253,298	992	0.4%	
Artery N of Northern Ave on-ramp									
Northbound	1854-1855	99,000	93,961	93,969	107,309	112,234	4,925	4.6%	6282-6147
Artery S of Haymarket on-ramp									
Southbound	2044-1860	90,000	88,661	88,227	124,140	125,755	1,615	1.3%	6160-6161
Total		189,000	182,622	182,196	231,449	237,989	6,540	2.8%	
Artery @ Mass Turnpike									
Northbound	2530-2531	74,000	80,611	82,002	85,680	88,125	n/a	n/a	
Southbound	2517-2518	87,000	82,380	83,317	92,699	92,158	n/a	n/a	
Total		161,000	162,991	165,319	178,379	180,283	n/a	n/a	
Central Artery S of Causeway									
Northbound	2039-2040	99,000	95,188	94,754	133,561	136,595	3,034	2.3%	6151-6152
Southbound	2041-2042	92,000	91,660	90,417	140,087	140,038	-49	0.0%	6157-6206
Total		191,000	186,848	185,171	273,648	276,633	2,985	1.1%	
Artery Bridge									
Northbound	2113-1834	92,000	86,518	88,823	133,561	136,595	3,034	2.3%	6152-6153
Southbound	1833-2116	87,000	92,627	90,342	140,087	140,038	-49	0.0%	6156-6157
Total		179,000	179,145	179,165	273,648	276,633	2,985	1.1%	

Table 4.3-3a. 2010 AWDT Volumes on Central Artery: Base Case and MED SCHEME.

		1	2	3	4	5			
	1987 Link	1987 Count	CTPS 1987 Base	EMME/2 1987 Base	EMME/2 2010 Base	EMME/2 MED SCHEME	(5-4) DIFF	(5-4)/4 % DIFF	2010 Link
Turnpike Eastbound									
TP W of Beacon Park	5477-5478	57,500		62,014	74,845	74,845	0	0.0%	
Beacon Park off	5478-1664	17,500		14,381	13,681	11,751	-1,930	-14.1%	
Beacon Park on	1651-5484	15,000		17,034	19,114	21,036	1,922	10.1%	
TP E of Beacon Park	5484-5485	55,000	59,813	64,667	80,277	84,130	3,853	4.8%	
Copley off	2411-2297	13,000		16,609	18,303	18,406	103	0.6%	
TP W of CA	2414-2415	42,000	44,565	48,057	61,974	65,724	3,750	6.1%	2414-6333
TP E of CA	6141-6430	n/a	n/a	n/a	37,563	40,577	3,014	8.0%	
Turnpike Westbound									
TP E of CA	6604-6429	n/a	n/a	n/a	50,802	51,955	1,153	2.3%	
TP W of CA	2405-2406	40,000	39,984	43,608	61,413	64,542	3,129	5.1%	
Arlington on	5600-2406	4,500		4,837	4,250	6,123	1,873	44.1%	
TP W of Arl on	2406-2407	44,500	44,629	48,444	65,663	70,665	5,002	7.6%	
Clarendon on	2350-2407	1,000		2,426	1,017	251	-766	-75.3%	
TP W of Clar on	2407-2408	45,500		50,870	66,680	70,916	4,236	6.4%	
Copley Sq on	2296-2408	5,500		4,651	6,047	7,101	1,054	17.4%	
TP W of Copley	2408-2409	51,000	52,069	55,521	72,728	78,017	5,289	7.3%	
Mass Ave on	3236-3424	3,000		3,304	3,931	2,526	-1,405	-35.7%	
TP E of Beacon Park	5486-5483	54,000		58,824	76,658	80,543	3,885	5.1%	
Beacon Park off	5483-1658	15,000		15,351	17,589	18,925	1,336	7.6%	
Beacon Park on	1667-5479	17,000		12,842	11,472	8,924	-2,548	-22.2%	
TP W of Beacon Park	5479-5476	56,000		55,955	70,542	70,542	0	0.0%	

Table 4.3-3b. 2010 AWDT Volumes on the Mass Turnpike: Base Case and MED SCHEME.

Location	Link	1 1987 Count	2 1987 EMME/2	3 2010 EMME/2	4 MED SCHEME	(4-3)/3 DIFF
Beacon Hill/West End/Gov Center						
Charles S of Mt.Vernon SB	2214-2233	7,500	9,525	8,813	15,307	73.7%
Beacon N of Walnut EB	2228-2227	14,500	7,810	7,575	11,059	46.0%
Beacon N of Walnut WB	2227-2228	7,500	3,540	4,291	5,701	32.9%
Bowdoin N of Beacon NB	2225-2223	14,000	5,698	5,097	9,354	83.5%
Cambridge W of Joy EB	2172-2173	20,000	17,883	14,855	12,507	-15.8%
Cambridge W of Joy WB	2173-2172	20,000	15,941	16,582	15,597	-5.9%
New Sudb E of Camb EB	2175-2073	18,000	18,587	18,493	18,965	2.6%
New Chardon E of Camb WB	2074-2174	21,500	22,695	17,872	18,175	1.7%
Staniford S of Causeway NB	2082-2084	9,500	9,326	8,608	9,143	6.2%
Staniford S of Causeway SB	2084-2082	8,000	6,107	14,280	17,687	23.9%
average increase						*12.8%*
Kenmore Square/Fenway Area						
Comm Ave W of Essex St EB	5503-5512		18,330	19,154	20,271	5.8%
Comm Ave W of Essex St WB	5502-2568		25,143	26,048	25,176	-3.3%
Comm Ave W of K. Square EB	5420-5426		6,726	7,934	6,363	-19.8%
Comm Ave W of K. Square WB	5423-2697		12,689	13,840	12,304	-11.1%
Comm Ave E of K. Square EB	5422-5611		18,317	21,619	21,433	-0.9%
Comm Ave E of K. Square EB	5614-5423		14,631	18,530	16,257	-12.3%
Beacon St W of K. Square EB	5609-5427		4,869	7,931	7,547	-4.8%
Beacon St W of K. Square WB	5426-5608		8,336	13,141	13,077	-0.5%
Brookline Ave S of K. Square NB	2705-5610		9,112	8,541	9,688	13.4%
Brookline Ave S of K. Square SB	5610-2705		10,871	12,166	9,141	-24.9%
Boylston E of Brookline EB	2705-3183		20,129	21,087	20,040	-5.0%
Boylston E of Brookline WB	3183-2705		18,534	20,807	20,900	0.4%
Fenway S of Boylston NB	2694-3429		13,737	16,614	16,172	-2.7%
Fenway S of Boylston SB	3429-2694		6,897	6,870	1,492	-78.3%
average increase						*-7.2%*

Table 4.3-4a. Counts/AWDT Volumes in Beacon Hill/Kenmore (2010/MED SCHEME).

Overall, it can be stated that of the 60,000 vehicles which would no longer use Storrow Drive about a quarter move to Memorial Drive, one-sixth to the Turnpike, one-fifth to Back Bay East-West arterials, with the remainder, about 20,000 vehicles, scattered throughout the system on Cambridge roads, Boston arterials to the South, and the Central Artery.

For the LOW SCHEME and FULL SCHEME, some graphic analysis was also performed. As can be seen in **Figure 4.3-3**, the changes to Storrow Drive under the LOW SCHEME assumption, compared to the 2010 base case, have little impact on traffic distribution both in the larger system and in the adjacency of the study area. On the other

Location	Link	1 1987 Count	2 1987 EMME/2	3 2010 EMME/2	4 MED SCHEME	(4-3)/3 DIFF
Charlestown Locations						
Sullivan Sq overpass NB	3459-3461	9,000	9,868	11,933	11,878	-0.5%
Sullivan Sq overpass SB	3462-3460	14,000	10,274	14,606	14,063	-3.7%
Rutherford N of Austin NB	3321-3322	20,000	17,388	31,161	32,914	5.6%
Rutherford N of Austin SB	3394-3327	30,000	30,301	32,330	30,460	-5.8%
Rutherford N of City Sq NB	3316-3317		19,860	32,959	32,104	-2.6%
Rutherford N of City Sq SB	3330-3315		29,323	29,001	27,497	-5.2%
Prison Point Bridge EB	3393-3338	14,000	29,703	29,374	32,543	10.8%
Prison Point Bridge WB	3340-3390	13,500	32,988	29,555	28,916	-2.2%
average increase						*-0.3%*
Cambridge Locations						
Mem W of Longfellow EB	4380-3635	23,000	21,239	25,525	36,054	41.2%
Mem W of Longfellow WB	3636-4379	17,500	17,925	20,044	25,018	24.8%
Mem S of River St Bridge EB	4418-4419		9,996	11,735	12,564	7.1%
Mem S of River St Bridge WB	4419-4418		8,576	10,548	10,255	-2.8%
Mass Ave N of Main St NB	4484-4481		13,451	15,112	16,330	8.1%
Mass Ave N of Main St SB	4481-4484		17,179	18,861	20,731	9.9%
Cambridge W of O'Brien EB	3472-3470	23,000	14,695	20,620	22,492	9.1%
Cambridge W of O'Brien WB	3470-3472	15,500	11,049	14,688	15,991	8.9%
Cambridge W of 1st EB	3473-3472	7,000	7,929	7,596	8,961	18.0%
Cambridge W of 1st WB	3472-3473	6,500	8,389	10,056	10,104	0.5%
O'Brien N of Cambridge NB	3469-3540	18,000	13,129	20,195	19,489	-3.5%
O'Brien N of Cambridge SB	3541-3470	20,500	18,496	24,553	22,534	-8.2%
McGrath N of SV Ave NB	5258-5245	20,000	13,613	19,185	20,889	8.9%
McGrath N of SV Ave SB	5246-5259	23,000	14,487	16,211	17,149	5.8%
Main W of Longfellow EB	3637-3632	14,000	14,577	16,262	16,924	4.1%
Main W of Longfellow WB	3631-3638	16,500	17,098	17,573	18,991	8.1%
average increase						*8.7%*

Table 4.3-4b. Counts/AWDT Volumes in Cambridge Charlestown (2010/MED SCHEME).

hand, as **Figure 4.3-4** illustrates, the FULL SCHEME version of a downgraded Storrow Drive, with lower design capacities and a slower one-way connection from and to the Fenway, has larger traffic impacts in the vicinity of Charlesgate. While Boylston Street volumes to the west of Charlesgate decrease substantially due to the absence of an overpass/tunnel and a slower surface connection to link this area with Storrow Drive, increases can be seen especially on Beacon Street and its surface connections with Storrow Drive, as well as on roadways directly east and west of Charlesgate, including the Massachusetts Turnpike. Slight to medium increases in volumes also occur on most Charles River crossings but are hardly visible in Cambridge which implies that this additional traffic is scattered throughout the Boston and Cambridge road network.

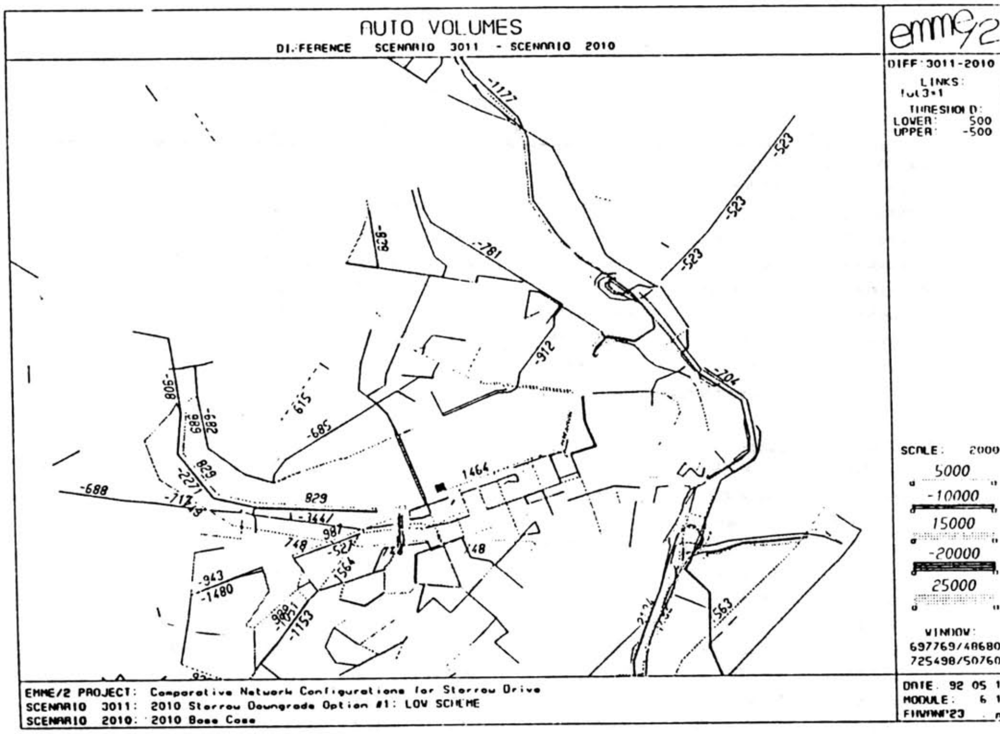


Figure 4.3-3. 2010 Ext. Core AWDT Volume Comparison: LOW SCHEME - Base Case.

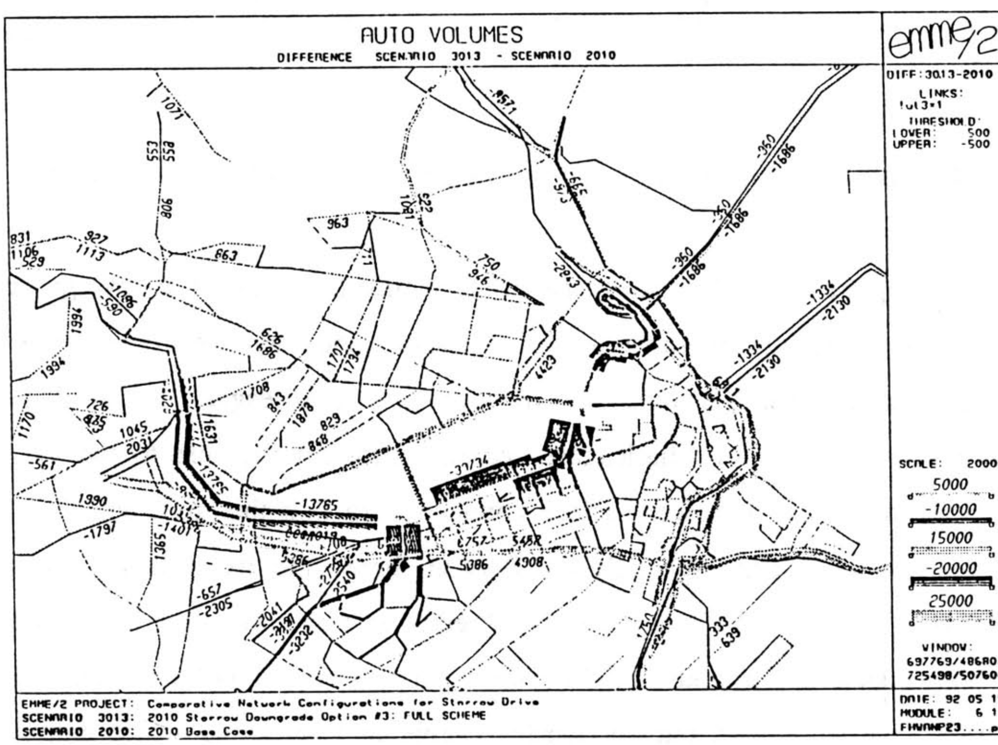


Figure 4.3-4. 2010 Ext. Core Volume Comparison: FULL SCHEME - Base Case.

4.3.3. Study Area

The reduction in capacity and speeds along Storrow Drive between Charlesgate and Leverett Circle to the amounts specified in Chapter 4.2 and reconfiguration of ramps will lead to a decrease in traffic volumes of between one-half to two-thirds for the MED SCHEME and FULL SCHEME, respectively. For the LOW SCHEME downgrading scheme, volumes stay approximately constant. **Table 4.3-5** shows the changes in Storrow Drive and ramp volumes for the MED SCHEME. It can be seen that, by and large, decreases in ramp volumes are in the same proportion as decreases on the Storrow Drive mainline between Charles Circle and Charlesgate. This could lead to the conclusion that while Storrow Drive is only used by about half the number of motorists under the downgrading scheme, the mix of users remains approximately the same.

The following discussion is based on assignment results most of which are listed in **Table 4.3-5**.

At Charles Circle, about 10,000 additional vehicles would exit from Storrow Drive Westbound to primarily access Charles Street southbound — in lieu of the replaced Arlington Street exit — and via the Longfellow Bridge to Memorial Drive, which absorbs some of the traffic diverted from Storrow. A similar increase — smaller, because Charles Street is one-way southbound — can be seen in the ramp volumes from Charles/Blossom Street to Leverett Circle, probably representing Memorial Drive-Longfellow Bridge users trying to access the Interstate system at Leverett Circle. From and to the South, ramp volumes connecting Charles Circle and Storrow Drive are reduced by over 50% as a consequence of fewer motorists using Storrow Drive to reach Beacon Hill/Government Center destinations, and vice versa. Part of the resulting diversion, as was discussed in the previous section, occurs on Staniford, Tremont and Beacon Streets which are alternative routes to reach this part of the downtown. Overall volumes on Cambridge Street are reduced because of the reduced-capacity connection with Storrow Drive.

In the Arlington/Berkeley Ramp Area, switching of the off-ramp location from Arlington to Dartmouth Street will result in their lower utilization by vehicles trying to access points to the south of Boston Common, as was shown in the previous section, and

	1987 Link	1 1987 Count	2 1987 Base	3 2010 Base	4 MED SCHEME	(4-3) DIFF	(4-3)/3 % DIFF	2010 Link
Soldiers Field Road/Storrow Drive Eastbound								
SF Road N of Western	5415-5416		30,770	35,154	33,643	-1,511	-4.3%	
Western Ave off	5416-3113		6,606	7,906	8,131	225	2.8%	
SF Road S of Western	5416-5417		24,164	27,249	25,512	-1,737	-6.4%	
River St on	3111-5417		8,719	8,946	4,009	-4,937	-55.2%	
BU off	1820-5495		5,424	5,925	6,003	78	1.3%	
BU on	5495-1820		6,808	7,267	4,837	-2,430	-33.4%	
SD W of Fenway	1820-3456		34,267	37,537	28,355	-9,182	-24.5%	
Charlesgate off	3456-3452		2,644	2,308	7,457	5,149	223.1%	7014-3449
Fenway off	3453-3451		10,161	10,855	9,242	-1,613	-14.9%	3456-7021
Total off			12,805	13,163	16,699	3,536	26.9%	
SD @ Muddy River	3413-3404	29,000	22,526	24,373	11,656	-12,717	-52.2%	7014-7011
Fenway on	3434-3414		19,102	22,510	n/a			
Charlesgate on	3415-3414		10,526	11,131	12,907	1,776	16.0%	3415-7011
Total on	3414-3404	24,500	29,628	33,641	12,907	-20,734	-61.6%	
SD E of Mass	3404-2464	53,500	53,225	58,014	24,563	-33,451	-57.7%	3404-7000
Hereford on		n/a	n/a	n/a	1,781			3094-7000
Gloucester off		n/a	n/a	n/a	520			7001-3043
Fairfield on		n/a	n/a	n/a	1,788			2695-7002
Exeter off		n/a	n/a	n/a	1,953			7003-2688
Dartmouth off	2464-2465	2,000	1,721	1,622	n/a			
Clarendon off	2464-2459	3,500	3,087	3,140	3,936	796	25.4%	
Arlington off	2311-2309	7,500	4,221	4,039	n/a			
Berkeley on	2306-2291	13,000	16,217	18,692	15,325	-3,367	-18.0%	2368-2311
Embankment on	2212-2211	9,000	5,654	8,578	n/a			
Total Back Bay off		13,000	9,029	8,801	6,409	-2,392	-27.2%	
Total Back Bay on		22,000	21,871	27,270	18,894	-8,376	-30.7%	
SD @ Revere	2209-2190	62,500	67,799	79,932	40,710	-39,222	-49.1%	
CC off-ramp	2190-2184	17,500	20,761	15,895	7,388	-8,507	-53.5%	
SD E of CC off	2190-2188	45,000	44,202	61,848	31,618	-30,230	-48.9%	
Charles/Blossom on	2145-2103	14,000	3,077	8,913	14,253	5,340	59.9%	2145-6485
SD W of Leverett (surface)	2103-2104	59,000	47,279	21,204	18,715	-2,489	-11.7%	6485-6254
SD W of Leverett (tunnel)			n/a	49,557	27,156	-22,401	-45.2%	6483-6495
ramps to I-93	2105-2106		41,883	73,685	58,918	-14,767	-20.0%	6248-6249
Storrow Drive/Soldiers Field Road Westbound								6245-2126
ramps from I-93	2120-2121		48,890	74,846	71,170	-3,676	-4.9%	6242-6243
Leverett off	2121-2093		14,269	21,253	25,471	4,218	19.8%	6243-6247
Leverett on	2125-2126		27,805	16,456	8,109	-8,347	-50.7%	6253-2126
SD W of Leverett	2126-2146	62,000	62,426	70,050	53,808	-16,242	-23.2%	
CC off	2146-2155	12,500	9,265	12,424	23,153	10,729	86.4%	2126-2155
SD W of CC off	2146-2147	49,500	53,161	57,626	30,655	-26,971	-46.8%	2146-2188
CC on	2148-2159	11,000	14,484	13,425	5,874	-7,551	-56.2%	7004-2189
SD @ Revere St	2189-2210	60,500	67,645	71,051	36,529	-34,522	-48.6%	
Arlington off	2295-2309	17,000	22,027	21,224	n/a			
Berkeley St on	2368-2460	9,500	9,399	10,857	7,048	-3,809	-35.1%	2368-2463
Dartmouth St off		n/a	n/a	n/a	10,971			2463-2465
Total Back Bay off			22,027	21,224	10,971			
Total Back Bay on			9,399	10,857	7,048			
SD E of Mass Ave	2463-3065	53,000	55,017	60,664	32,606	-28,058	-46.3%	
Mass Ave off	3405-3406	2,000	336	2,531	1,882	-649	-25.6%	
SD W of Mass Ave off	3405-3437	51,000	54,680	58,134	30,724	-27,410	-47.1%	3405-7010
Fenway off	3440-3442		18,864	20,312	17,940	-2,372	-11.7%	7010-7013
Charlesgate off	3440-3450		18,559	19,899	7,615	-12,284	-61.7%	7012-3415
Total off	3437-3440		37,423	40,211	25,555	-14,656	-36.4%	
SD @ Muddy	3437-3454		17,258	17,923	5,170			7012-7015
Charlesgate on	3436-3438		3,111	4,565	4,258	-307	-6.7%	3449-7015
Fenway on	3435-3438		11,581	11,589	20,650	9,061	78.2%	7020-3455
Total on	3438-3455		14,692	16,154	24,908	9,061	78.2%	
SD W of Fenway	3455-1821		31,949	34,077	30,077	-4,000	-11.7%	
River St off-ramp	1824-3112		10,442	10,517	7,277	-3,240	-30.8%	
SF Road S of Western	1824-1825		21,507	23,560	22,800	-760	-3.2%	
Western Ave on-ramp	3114-1825		8,456	9,250	10,845	1,595	17.2%	
SF Road N of Western	1825-1826		29,963	32,810	33,645	835	2.5%	

Table 4.3-5. 2010 AWDT Volumes on Storrow Drive: Base Case and MED SCHEME.

the downgrading in a general reduction of traffic crossing the Back Bay in North-South direction. This reduction is a direct consequence of more vehicles accessing the commercial area around the Prudential and Hancock Towers from the Turnpike rather than from Storrow Drive.

The cross streets connected with Storrow Drive carry small volumes of traffic to and from the expressway-now-parkway and volumes increase slightly on these local streets, as was seen in the previous section. It should be noted, however, that these increases might not reflect what would actually happen since the existing Back Street is not coded into the network, although streets carry volumes of traffic to this service road comparable to those forecast for the downgrade scheme.

At Charlesgate, the number of vehicles using the Bowker overpass/tunnel between the Fenway and Storrow Drive East are reduced by about 25,000, primarily as a consequence of the eliminated ramp from the Fenway to Storrow Drive eastbound and the downgrading itself, and partially because of the elimination of the westbound section of Boylston Street between Massachusetts Avenue and the Fenway. The connection between the Fenway and Storrow Drive West, on the other hand is used by about 25% more vehicles, primarily as a consequence of motorists trying to avoid the lower-capacity section of Storrow Drive to the East and partially because simplified intersections in the Fenwy area — along Boylston Street, Park Drive and the Fenway — lead to a slight increase in capacity south of the Turnpike. At the surface, some additional movements between Charlesgate and Storrow Drive eastbound occur as a consequence of the eliminated Boylston Street/Bowker connection. It is interesting to note, that westbound through traffic on Storrow Drive is only one-sixth of the total volumes near Massachusetts Avenue and the comparable percentage is about one-third in eastbound direction. This indicates that only a small share of traffic uses Soldiers Field Road/Storrow Drive as a route between points West and downtown locations. Therefore, the downgrading results in Storrow Drive ceasing to act as a principal regional highway link to points in the West and Northwest.

Part II has developed several possible futures for Storrow Drive. Improvement schemes, as examined along the criteria established in Chapter 3, were evaluated in terms of their impacts on local and regional traffic distribution. The analysis showed that envisioned forms of downgrading Storrow Drive could effect increases on selected Boston and Cambridge arterials, as well as the Central Artery and Mass Turnpike to a varying degree.

The formulated intent was to propose urban design improvements and then find methods to mitigate their impacts on traffic. The following section deals with possible mitigation policies and examines important factors which will affect the implementability of any of the downgrading schemes.

PART III
REALIZING THE VISION

In Part II of this paper, we have examined various downgrading options for Storrow Drive. All of these options were motivated by the objective to achieve a better connection to the Charles River. It was argued that by making it easier for pedestrians to access the Esplanade from the abutting neighborhoods or via transit and by reducing the roadway along the park to expand the open spaces currently, separated elements of the urban system could be successfully re-integrated. The application of these concepts to specific barrier nodes along Storrow Drive illustrated the existing and future opportunities to realize the urban/environmental objective.

It was also shown that some of the described downgrading schemes could have direct traffic impacts. If the total number of vehicle trips is not limited simultaneously with reducing capacity along Storrow Drive, vehicles will find alternative routes and increase traffic volumes elsewhere. This effect was replicated in the traffic assignments of Chapter 4 which assumed that there would be no changes in automobile travel due to changes in the system.

While some increases in congestion could be justified on the grounds of the substantial environmental improvement along the Esplanade facilitated by the reduction of Storrow Drive's role, the question I seek to address in Chapter 5 is which measures could be applied to mitigate these traffic impacts.

The application of these policies serves as a kind of sensitivity analysis of travel in the subregion. How do certain measures affect how many trips are undertaken, by which mode and in which locations? An evaluation of these policies seeks to highlight to which extent they are compatible with the urban/environmental objectives formulated in Chapter 3.

In many respects, the objectives pursued in this study are complementary to the approach taken with projects elsewhere. This complementarity is examined on three levels in Chapter 6: First, is the environmental enhancement linked to the capacity reduction on Storrow Drive related to other ongoing (transportation) projects? Second, are the formulated policy objective compatible with those expressed by members of the affected constituency? And third, are there complementary forces which might support a realization of the envisioned concepts now more than at a different point in time? What are the unique opportunities?

Chapter 5
Policy Applications and Sensitivity Analysis

A downgrading of Storrow Drive could have some side effects in terms of shifting traffic to locations where it might be equally disruptive as along the Boston side of the Charles River itself. The traffic asssignments in Part II showed that, with limited capacity on Storrow Drive, vehicles would use alternative travel routes through the Back Bay, Cambridge and arterials to the South with only a small proportion shifting to the Turnpike and Central Artery.

The fixed trip table assumption underlying these traffic impact estimates does not take into account the many options available to the policy maker to affect the form and volume of automobile travel in the region. The congestion on roads which one can witness today underscores the need to reduce vehicular traffic in the city in general, not just in repsonse to capacity reductions along the Charles River. As was pointed out in Chapter 3, the achievement of the urban/environmental objectives associated with downgrading Storrow Drive is closely tied to increasing the role of transit in the region.

For the purpose of illustrating some of the options which exist today, a *sensitivity analysis* of various policy applications is performed. This serves the dual purpose of showing how successfully certain transportation objectives could be achieved through the application of specific measures as well as the extent to which they could mitigate traffic impacts associated with a downgrading of Storrow Drive in absence of other complementary strategies to reduce vehicle travel.

The upgrading of the Massachusetts Tunrpike, implementation of a parking freeze, as well as construction of circumferential transit are examined for this analysis because of their special history in Boston.

5.1. Upgrading the Massachusetts Turnpike

It is standard urban transportation practice to try to separate regional from local traffic by providing different facilities for each. Roads carrying regional traffic are typically designed as limited-access/limited-egress expressways which can move vehicles at high speeds with minimal interference from movements at on- and off-ramps.

Although the Turnpike is designed as a modern, eight-lane freeway and Storrow Drive as a hybrid of a conceived parkway and a realized highway, both carry comparable volumes of traffic. The Turnpike, having no access or egress points between Allston and Massachusetts Avenue and neither on-ramps eastbound nor off-ramps westbound east of Beacon Park, cannot serve a) vehicles from the East trying to exit at downtown, nor b) vehicles trying to access the Back Bay, Beacon Hill and other downtown locations from points in the Southwest. Many among these two groups of travelers will consequently use Storrow Drive with its connections at Charles Circle, the Arlington/Berkeley ramps and the Fenway to reach their destinations or, alternatively, Boston arterials to the South. Thus, as was pointed out in Chapter 1, Storrow Drive serves as both a regional highway link *and* a local distributor.

5.1.1. Policy Elements and Objectives

Various sources in the past have claimed that the Turnpike wasn't carrying its fair share and that its utilization could be increased to the benefit of parallel arterials.[124] It was pointed out in Chapter 1 that while the Massachusetts Turnpike is a well-designed, eight-line highway it carries only about one-half to two-thirds of the volumes of the Central Artery. While a downgrading of Storrow Drive will reduce the number of vehicles on it (Storrow), the percentage of these vehicles which would be diverted to the Turnpike is only about 15%, as was shown in Chapter 4.3 for the MED SCHEME. This indicates that, all else being equal, there is a low degree of substitutability between the two. To examine ways which would make the Turnpike more competitive with Storrow Drive, and to test substitution characteristics under a different configuration, the following changes are examined:

1. Addition of ramps at Kenmore Square, Berkeley and Arlington Streets.
2. Elimination of Turnpike Extension tolls.
3. Improvement of the Soldiers Field Road/Turnpike connection at Allston.

Addition of ramps in the locations indicated above have been favoured by the city for several years.[125] However, several issues about the impacts of an addition of the Arlington/Berkeley ramps have been raised. First, there are concerns about queuing from the Berkeley off-ramp onto the mainline between the Central Artery and the added ramp. Second, possible traffic impacts on the surface streets, such as Columbus Avenue, have met with some community opposition especially by Bay Village residents. Third, the volumes generated through the addition of these ramps could put some pressure on the responsible transportation planners to widen the Turnpike between the Central Artery and the ramps. A widening at this location might not be feasible from an engineering point of view — as might be the case with some of the Kenmore ramps — and, in addition, is very likely to seriously disrupt commuter and intercity rail operations during reconstruction.

For the purpose of sensitivity analysis, which is the objective here, it is assumed that the connections would be physically possible. As discussed above, these additions would improve the potential of the Turnpike to serve travelers coming from the Southwest to reach downtown locations as well as those coming from the Northeast or Southeast to access the Back Bay/Kenmore Square area. If this concept proved successful, vehicles currently entering Storrow Drive at Charlesgate destined for Boston Proper locations and those coming from I-93 North, Route 1 or 1A North with destinations between downtown and Allston, would have a viable alternative to using Storrow Drive. The first set of ramps would connect the Turnpike, both eastbound and westbound, with the surface system at Kenmore Square at Beacon and Brookline Street. The second set of ramps would be an eastbound on-ramp from Arlington Street and a westbound off-ramp to Berkeley Street, the latter necessitating the removal of the old Arlington on-ramp westbound.

Transportation consulting firms such as Vollmer Associates and Howard Needles and Associates have been commissioned to undertake detailed analyses of traffic impacts of these ramp additions. Unfortunately, these studies have not yet been released to the public. As a consequence, traffic assignments performed here will not incorporate any changes, such as local street direction reversals or other redesigns, which might be undertaken concurrently with the addition of the designated ramps.

Under this sensitivity analysis, the elimination of Turnpike Extension tolls and the improvement of design of the Allston interchange would both serve the purpose of increasing the appeal of the Turnpike for vehicles making their route choices in Allston. At this location, vehicles coming from Route 2 or 2A in the Northwest, from points West via Cambridge and Western Streets, or from Cambridge's Central Square area choose between taking the Turnpike, Storrow or Memorial Drive to reach destinations in the East. One of the effects which will be measured is the relative importance of shortening the time or reducing the cost of getting onto the Turnpike in relation to Storrow Drive traffic and the effect of improving access within Boston with added ramps. This analysis will provide some insight into the potential to shift traffic to the Turnpike while reducing speed and capacity on Storrow Drive

5.1.2. Model Representation

To measure the impacts these changes would have on traffic volumes, several modifications to the model network have to be applied.

The addition of ramps is coded into the network according to a modification scheme proposed by Vollmer Associates. **Figure 5.1-1** and **Figure 5.1-2** show the added links in the network with their coded hourly lane capacities for the Kenmore and Arlington/Berkeley ramps, respectively. Link characteristics such as capacity and free flow speed are directly taken from CTPS link prototypes as adopted by Vollmer and small adjustments were made to links in those locations where the ramps connect to the surface system.

By removing both the monetary toll and the cost imposed through a 30-second penalty at the toll station,[126] the toll elimination measure is accounted for in the new

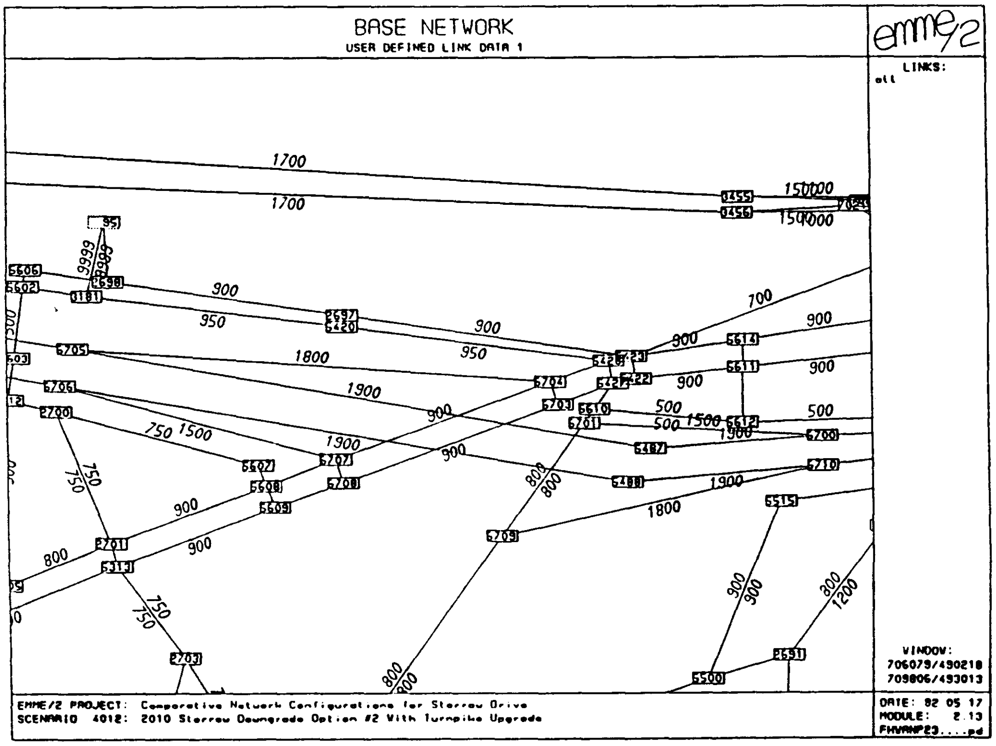


Figure 5.1-1. Network with Added Kenmore Ramps and Coded Lane Capacities.

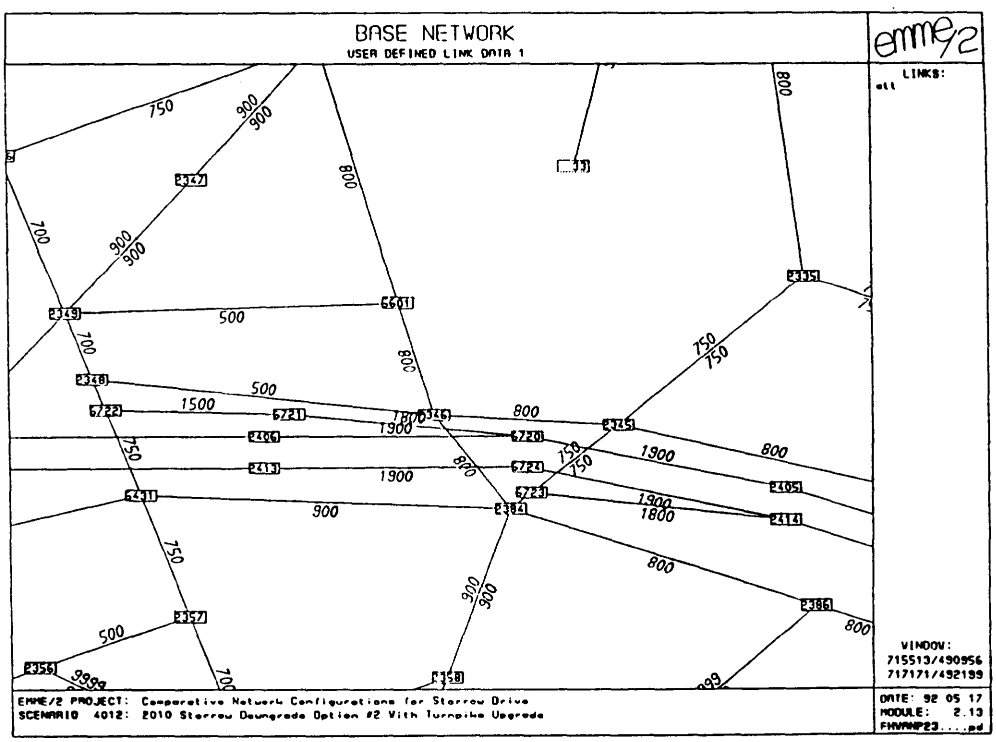


Figure 5.1-2. Network with added Arlington/Berkeley Ramps and Coded Lane Capacities.

network. Tolls are eliminated for traffic entering or leaving the Turnpike Extension at Beacon Park but maintained for through traffic on the Turnpike. An improved interchange design is simulated by creating a direct link connection between Soldiers Field Road and Beacon Park, as shown in **Figure 5.1-3**, again with links labeled with their hourly lane capacities. These links represent a connection between the two which has the capacity and free flow speed characteristics of Soldiers Field Road itself in this location.[127] This network configuration would correspond to a grade-separated option explored as part of the ongoing MTA study efforts.[128] All of the performed network changes to represent an upgraded Turnpike are shown in **Table 5.1-A1** in the appendix.

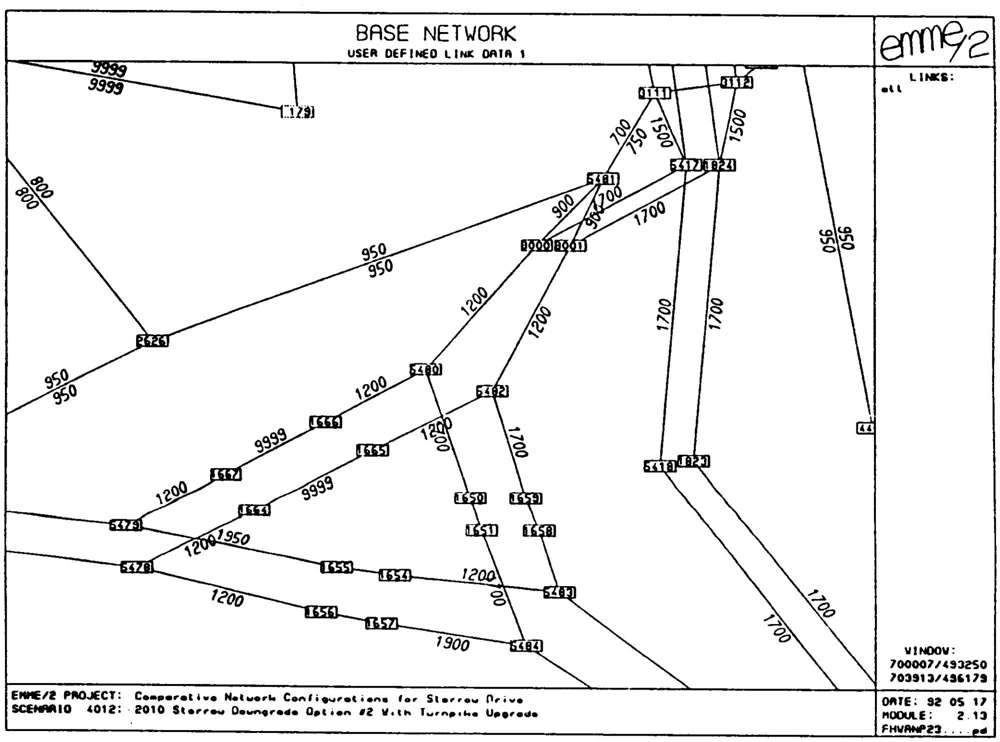


Figure 5.1-3. Network with Simulated Storrow - Turnpike Connector at Beacon Park.

It should be noted that the analysis of traffic impacts below still assumes a fixed trip table. This assumption is relaxed in Chapters 5.2 and 5.3.

5.1.3. Traffic Impacts

It could be seen from Chapter 4.2 that most traffic impacts at a greater distance from the study area are only minor. For the purpose of analyses in all of Chapter 5, I will therefore differentiate between three different analysis levels. The largest corresponds to the extended core analysis area. The second is a smaller section of the study area which contains all of the Back Bay and Beacon Hill Streets, but will be simply referrred to as the study area. Finally, a third level, applied only in Chapter 5.1, contains the focal areas which are of specific interest to the changes affected by a particular policy. In the Turnpike upgrade case, these are Beacon Park, Kenmore Square, and the Arlington/Berkeley ramp area. By now, the reader should have some familiarity with interpreting the information contained in the plots comparing auto volumes, and therefore only key observations will be noted in the text of this chapter.

5.1.3.1. Extended Core

Facilitated access from Soldiers Field Road at Beacon Park and addition of ramps at Kenmore Square, Arlington and Berkeley Streets, has substantial impacts on the utilization of the Massachusetts Turnpike Extension in Boston. The following descriptions are all based on a comparison between a network which includes both, the Turnpike upgrading characteristics *and* the Storrow downgrading features, and the 2010 base year network. As is illustrated in **Figure 5.1-4**, there are significant shifts of traffic from other arterials onto the Turnpike compared to the 2010 base case (Scenario 2010). (It should be noted again, that the "holes" in the comparative plots, as was the case in Chapter 4.3, are due to the elimination from the graphic of those parts of the network, where changed configurations in the form of altered links or nodes do not allow a standard link-by-link comparison.)

Since this graphic representation together with **Table 5-A2** and **Table 5-A3**, spot location and screen"ring" volumes, respectively, give a relatively detailed account of the degree and location of volume shifts, I will limit myself to stating some key observations from these comparisons:

- The volume decrease on Storrow Drive is matched by an approximately equal volume increase on the Massachusetts Turnpike,
- There are increases on virtually all roads leading to and from the Beacon Park Turnpike

connection, such as Soldiers Field Road West of Beacon Park and John F. Kennedy, Western Avenue and River Streets in Cambridge,

- Similarly, there are increases on roadways connecting to the new Turnpike ramps in the vicinity of Kenmore Square, such as the Pearl/Brookline Street one-way pair in Cambridge, and Beacon and Brookline Streets in Boston/Brookline, as well as in the vicinity of the Arlington/Berkeley ramps, such as Columbus Avenue and Tremont Street northbound,

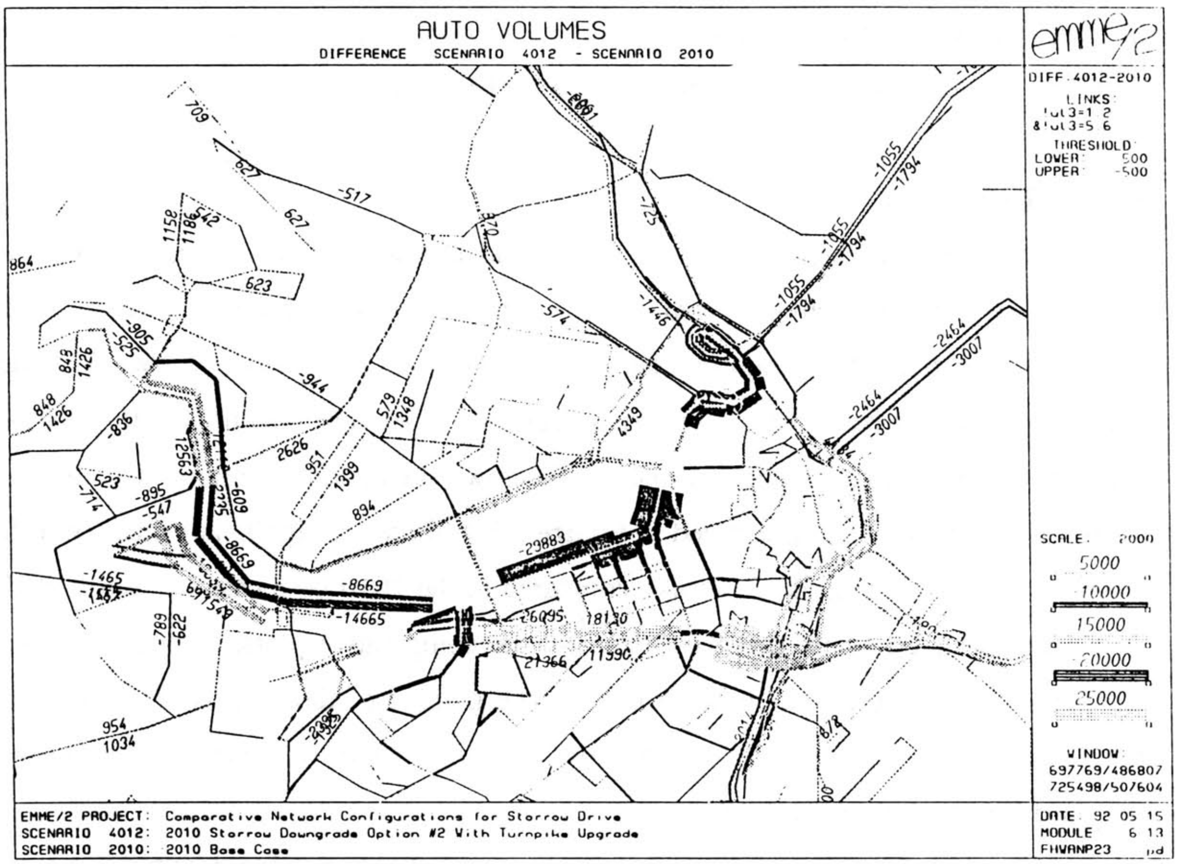


Figure 5.1-4. 2010 Ext. Core AWDT Volume Comparison: TPike Upgrade - Base Case.

- The creation of an access ramp to the Back Bay appears to shift some vehicles from arterials south of the Back Bay to a path along Morrissey Boulevard-Dorchester Avenue-Turnpike,
- Some Cambridge/Charlestown traffic in the East which previously used Rutherford

Avenue, Msgr. O'Brien Highway and the Charles River Dam seems to connect to points south via Cambridge arterials further west and the Beacon Park interchange,

- Volumes on Massachusetts Avenue are lower in many locations but higher in the vicinity of Harvard Square and on the Harvard Bridge,
- The Third Harbor Tunnel absorbs a large amount of traffic previously carried by the Sumner/Callahan tunnels.

5.1.3.2. Study Area

As can be seen in **Figure 5.1-5**, several changes in Back Bay and Beacon Hill traffic volumes will result from a downgrading scheme linked with the upgrading of the Massachusetts Turnpike Extension as specified. Some of the key changes can be summarized as follows:

- Increased volumes on arterials leading to and from the existing Turnpike ramps at Copley Square, such as St. James Avenue, Stuart Street and Dartmouth Street south of the off-ramp,
- Increased volumes on arterials leading to and from new Turnpike ramps, such as Columbus Avenue, Tremont Street northbound, the new Herald Street, and Berkeley and Arlington Streets south of Columbus Avenue,
- Decreases in North-South travel on streets in the Back Bay, such as Arlington, Berkeley and Clarendon Streets, and Charles Street south of Beacon Street,
- Decreases in traffic on Beacon Street west of Charles Street and a slight increase east of Charles Street,
- Volume shifts in the Back Bay due to the ramp reconfiguration from Arlington Street to the Dartmouth-Commonwealth-Exeter path, as was observed in the MED SCHEME,
- Increases on Memorial Drive, Longfellow Bridge and Charles Street north of Beacon Street similar to the MED SCHEME but to a lesser extent.

While the pattern of changes is comparable to those resulting from a downgrading scheme without a Turnpike upgrade, the provision of ramps at the new locations and facilitated connection at Beacon Park would lead to an overall reduction of traffic on surface arterials in the Back Bay and on some downtown streets, as well as in parts of Cambridge. However, the increases in traffic volumes on arterials leading to the Beacon Park interchange with the Massachusetts Turnpike, partially offset the benefits of the additional volumes absorbed by the highway. Therefore, addition of ramps to the Turnpike might be considered beneficial for Cambridge while the elimination of tolls and facilitated access might not. Under this snesitivity analysis, a positive spin-off effect would be achieved by the reduction of traffic volumes on all arterials surrounding the Boston Public Garden. In addition, volumes on most East-West roadways in the Back Bay streets would be left virtually unaffected.

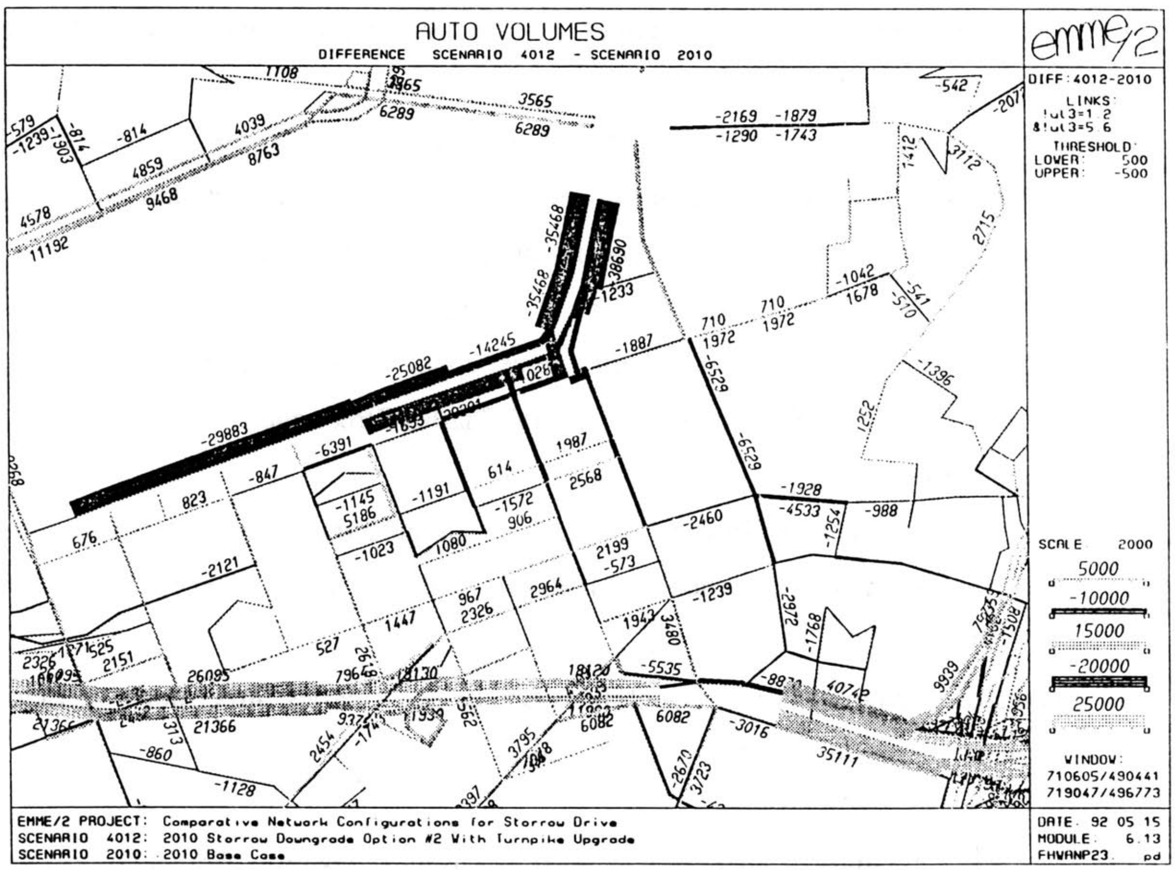


Figure 5.1-5. 2010 Study Area AWDT Volume Comparison: TPike Upgrade - Base Case.

5.1.3.3. Turnpike Focal Areas

A final point of interest is the utilization of the added ramps as well as of the improved connections at Beacon Park under this policy scenario. The ramps leading from Brookline Avenue to the Turnpike eastbound, and from the Turnpike westbound to Brookline Avenue in the vicinity of Kenmore Square, as shown in **Figure 5.1-6**, would be used by close to 20,000 vehicles each on an average weekday. The other pair of ramps, a westbound off-ramp to and an eastbound on-ramp from Beacon Street would only be used by 7,000 and 2,000 vehicles, respectively. This implies that there is large travel demand between the Kenmore Square area and southwestern locations to points east, but little demand to warrant an improvement of Turnpike connections between the Kenmore Square/Southwest area and points west. The relatively high volumes of traffic moving from Storrow Drive to Charlesgate, and vice versa, seem to indicate that these movements are still simpler and quicker using the Soldiers Field Road-Storrow Drive-Charlesgate connection.

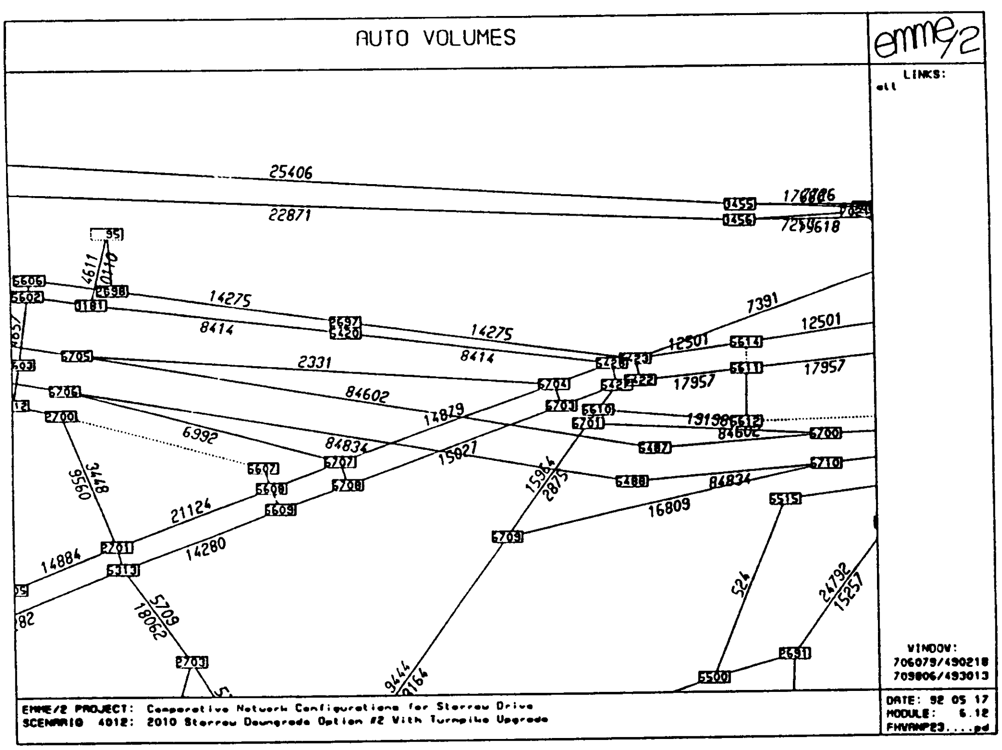


Figure 5.1-6. 2010 AWDT Volumes at Kenmore Ramps with Turnpike Upgrade.

As was the case with the eastern pair of Kenmore ramps, the Arlington and Berkeley, depicted in **Figure 5.1-7**, ramps would be used by approximately 20,000 vehicles each. This yields volumes on the Turnpike west of the Central Artery in the vicinity of 100,000 or 25,000 vehicles per lane in each direction which indicates that in spite of an assumed addition of lanes in each direction, the Turnpike would reach congestion levels[129]. The eastbound on-ramp is primarily used by vehicles coming from downtown locations and the Southwest via Columbus Avenue-Herald Street and Tremont Street. It will result in a reduction of traffic on Berkeley Street northbound which uses the Turnpike-Central Artery rather than the Berkeley Street-Storrow Drive-I-93 connection in the base case. Similarly, the Berkeley exit is used by vehicles which might have otherwise been using the Albany/Berkeley Street or Massachusetts Avenue exits from I-93 South. The volume reductions on Massachusetts Avenue and Berkeley Street south of Columbus, as well as Albany Street and Huntington Avenue northbound in the vicinity of the Turnpike seem to corroborate this finding.

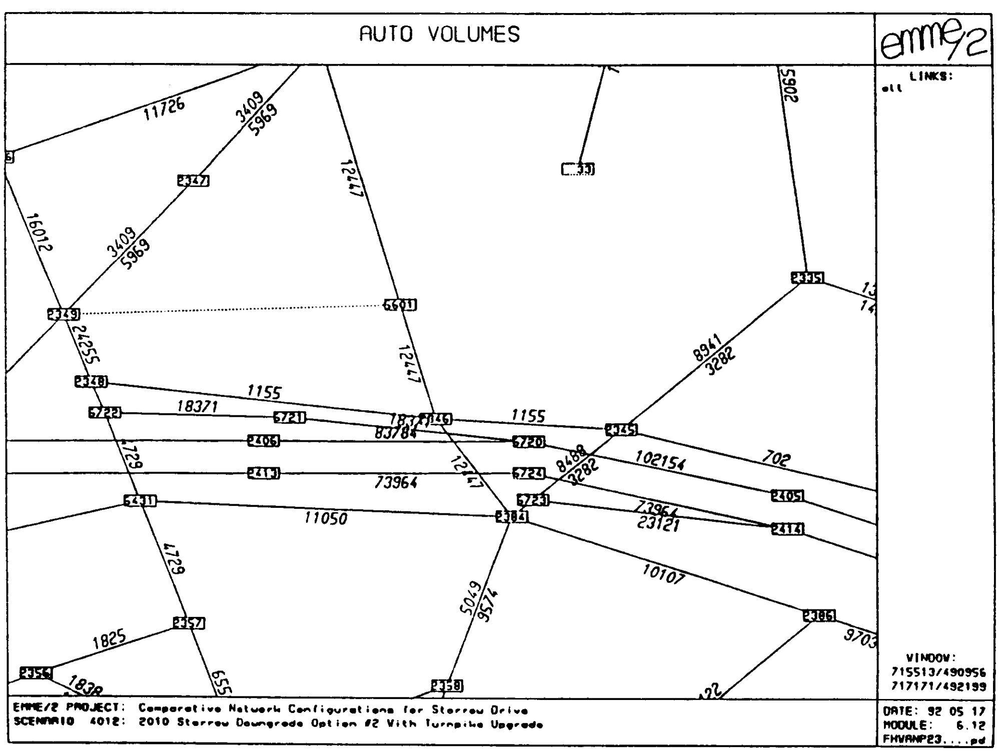


Figure 5.1-7. 2010 AWDT Volumes on Arlington/Berkeley Ramps with TPike Upgrade.

The labeled links plot in **Figure 5.1-8** shows that close to 50,000 vehicles would use the improved connection between Soldiers Field Road and the Turnpike, in addition to the approximately 55,000 vehicles which would continue using the existing surface connections. This means that over 100,000 vehicles "interchange" in this location which compares to a little more than 60,000 for both the base case and the MED SCHEME. The connection to the Boston Extension of the Turnpike is used by about 67,000 vehicles compared to about 37,000 and 40,000 vehicles for the base case and the MED SCHEME, respectively. This indicates that an improved connection at this interchange, as simulated by the model, would draw motorists onto the Turnpike and off of parallel arterials in Cambridge and Boston.

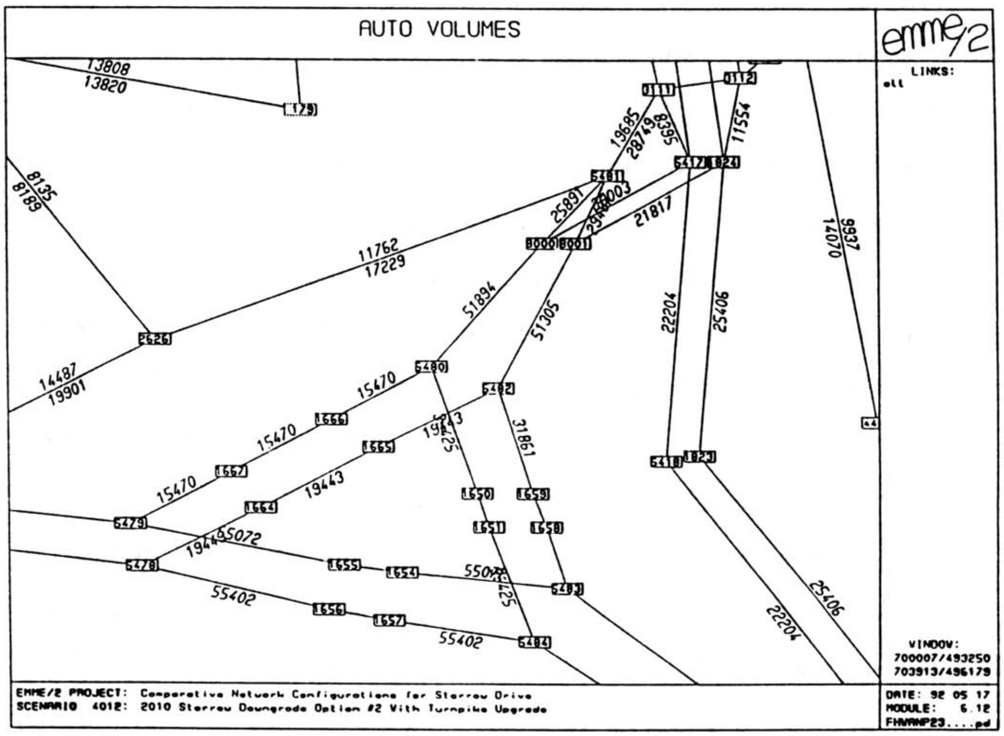


Figure 5.1-8. 2010 AWDT Volumes at Beacon Park with Improved Storrow Connection.

One question of interest raised at the beginning of this chapter was the extent to which the Turnpike would be used as a substitute facility to Storrow Drive if the former were upgraded while the latter downgraded. When comparing traffic volume shifts on both corridors compared to the year 2010 base case it can be shown that, under the given network assumptions, about three-quarters of the volume decrease on a downgraded Storrow Drive would be absorbed by the Massachusetts Turnpike through the addition of ramps and a facilitated connection at Beacon Park.[130] This means that, in theory and in terms of *route choice*, as simulated by the assignment process, the Massachusetts Turnpike could indeed serve as a primary substitute facility for Storrow Drive and absorb the majority of trips diverted from the latter.

5.1.4. Policy Implications

The results of the above sensitivity analysis indicate that under the idealized assumptions that all ramps could be constructed and a highway connection at Beacon Park be achieved, the Turnpike could absorb a significant amount of traffic from the parallel surface system and serve some important distributor functions in the Back Bay and Chinatown areas. The transportation costs associated with such an upgrade, beyond those associated with disruptions during construction, are primarily felt by those residents in Cambridge and Boston who live along access paths to the added ramps or Beacon Park.

While the addition of new ramps to the Turnpike would be functionally useful, neighborhood concerns in Chinatown and Bay Village suggest that alternatives to this option be explored. One of these would be the reconfiguration of Marginal and Herald Street to create a Herald Boulevard. Such a two-lane arterial, which could be tied to Turnpike air-rights developments in the area, could improve access to closely located ramps of the Interstate sytem in the vicinity of the new I-90/I-93 interchange.

The disruptive effect on rail operations associated with a potential widening of the Turnpike to accomodate these ramps contradict the objectives formulated in Chapter 3. Alternatives to such a capacity expansion would be the effective management of congestion through the introduction of Automatic Vehicle Identification (AVI) technology. The proper mangement of existing transportation facilities will need to replace the ideology of continued capacity expansions.

The downgrading of Storrow Drive and parallel facilities, such as Memorial Drive in Cambridge, can actually help achieve this objective. While an introduction of a more stringent pricing scheme on the Turnpike would tend to divert vehicles onto these parallel facilities along the Charles River, their downgrading could preclude such a traffic spillover. Therefore, a capacity reduction of Charles River arterials could contribute to the more efficient management of automobile transportation in the future.

5.2. Implementing a Parking Freeze

Parking policies have been cited as being the most powerful policy tool to reduce inner city automobile trips.[131] While they do not constrain travel per se, the removal of or additional charge for parking space at the destination location will increase the total cost for a vehicle trip. In the case of a parking freeze, the higher cost is incurred through the limited supply which in turn increases parking rates. This might result in higher occupancy rates, to divide the cost among more people, a shift to public transportation, or, in the extreme case, in trip reductions.

Some argue that, in the longer run, this might also affect destination choices and development patterns as more remote sites with ample and free parking become competitive with the more conveniently located but parking-constrained central areas. Others claim that the provision of free parking encourages levels of drive-alone commuting which unnecessarily add traffic to the limited road capacity in inner city neighborhoods. In fact, in the Back Bay, employees who receive free parking are two-and-a-half times more likely to drive alone to work than those receiving transit passes or a rideshare subsidy.[132]

Boston has a tradition of encouraging downtown development. As long as the discouragement of automobile travel in Boston is linked to the continued provision of superior transit connections, the vitality of the urban pedestrian environment and accessibility of public open spaces will help to maintain and improve the central area's attractiveness.

5.2.1. Policy Elements and Objectives

In 1975, the Environmental Protection Agency developed a transportation control plan for Massachusetts that included parking freezes in Cambridge and portions of Boston, incentive programs to reduce single-passenger commuter vehicle use, and the Logan Airport parking freeze.[133] The primary motivation for these measures were air quality concerns and the intent to achieve compliance with federal standards established in the Clean Air Act. However, lack of enforcement of these measures in Cambridge and loopholes in the downtown and Logan airport freeze[134] have led to significant growth in even those areas where the freeze was applied. Parking supply in downtown Boston grew by almost 20% between 1983 and 1989 with the majority of the new spaces created by private developers.[135]

An amendment to the Logan Airport parking freeze was proposed in 1988 by the Metropolitan Planning Organization (MPO) to expand the previous enforcement area and as a response to substantial growth in air travel. Since the original freeze was limited in area to Logan Airport, Park and Fly operations began sprouting up at the fringes and in residential districts of East Boston. The revision was also supported by the claim that, due to the limited number of commercial parking spaces available to passengers at airport locations, the number of drop-off trips had been increasing steadily with the effect of increasing vehicle-miles travelled by automobile. This reversed the original objective of limiting automobile travel to Logan and reducing emissions.

As a response to growing development in the South Boston Piers area, two further amendments to the orignal 1975 parking freeze were drawn up in 1990. The first was a proposal for a parking freeze in South Boston, the second for East Boston/Revere which attempted to improve and prevent the recurrence of problems of the original freeze.[136] As was stated plainly in one of these proposals that

> "the existence of plentiful parking facilities creates an incentive to drive. A lack of plentiful parking, in contrast, provides incentives for transit alternatives."[137]

The new parking freeze proposals aim at resolving problems of traffic congestion and air quality degradation which are related to economic development and emphasize the need to maintain accessibility to businesses through improvements of transit services in lieu of a provision of ample parking.

5.2.2. Model Representation

In conventional CTMs, a parking freeze is not modeled. While the availablity of parking at the destination location is an important determinant of modal choice, only the cost of parking but not its supply is represented as a variable in the modal utility comparison which serves as the analytical base for determining the choice of a means of travel. One way of representing limited supply of parking in a model would be to code an infinite terminal time — the average access/egress time added to travel time to reach the final destination — but since analysis for this paper is constrained in that it operates on a fixed trip table, the modal shifts resulting from this disutility increase for the auto mode cannot be estimated.[138] Ideally, in terms of the potential to realistically replicate actual choice behavior, parking supply would enter at the trip generation and trips distribution steps in the sequential modeling process because the existence of guaranteed parking actually affects the choice *whether* to travel by car at all, and for others, *where* to travel.

For the purpose of conducting a sensitivity analysis, a simplified and abbreviated approach is used.

First, it is assumed that the parking freeze applies to all of Boston and Cambridge, representing MDPW zones 1-216 in the 283-zone system.[139] Second, it is assumed that growth in vehicle trip ends in the zones affected by the parking freeze will only be 20% of the system average allowing for the completion of already approved parking facilities. Third, average parking occupancy rates are assumed to stay constant at 1987 levels where they were between 85% and 90%.[140] The parking freeze is simulated by allowing trips with destinations in zones 1-216 to grow by 3.5% while all other trips increase according to the demand projected in the 2010 trip table. A C-program then uses this information to construct a new trip table with reduced trip ends in the areas affected by the parking freeze (zone criterion).

While this approach is non-behavioral and top-down, and does not provide any analysis on what would "happen" to the forfeited trips, it is a useful and simple tool to illustrate the *magnitude* of traffic impacts effected by a parking freeze of this sort.

5.2.3. Traffic Impacts

The parking freeze, as modeled for the purposes of sensitivity analysis, would reduce the number of subregion-wide vehicle trips by about 200,000 daily. This would correspond to a growth in vehicle travel from 1987 levels of about 60% of the projected rate for 2010. The distribution of this reduction is illustrated below where the generated parking freeze trip table is combined with the MED SCHEME Storrow downgrade network and compared to the 2010 base case.

5.2.3.1. Extended Core

The largest reductions in traffic volumes occur along specific corridors, as depicted in **Figure 5.2-1**, representing volume differences on links between the MED SCHEME with a parking freeze (Scenario 5012) and the base case.

- To the Northeast, traffic volumes would be reduced in all tunnels, the Sumner, Callahan and Third Harbor Tunnel by an average 15% or approximately 15,000 vehicles per crossing, with the greatest reductions occurring in the Callahan Tunnel,
- To the North, large reductions can be seen on the southbound directions of Rutherford Avenue, I-93 and McGrath/Msgr. O'Brien Highway on the order of 6,000-8,000 vehicles, as well as on the Charlestown and Artery bridges in both directions,
- To the Northwest, the largest volume reductions occur on Route 2 and the arterials connecting to it on the East, Memorial Drive and especially Soldiers Field Road, adding to a total of more than 10,000 vehicle trips,
- To the West, there is a decrease of close to 10,000 vehicles in eastbound direction,

while there is an increase in westbound volumes attributable to the downgrading of Storrow Drive east of Charlesgate,

- To the Southwest, decreases are shown for Commonwealth Avenue, Beacon Street, Brookline Avenue, the parkways, Columbus Avenue and Washington Street, totalling more than 20,000 vehicles,
- To the South and Southeast, traffic volumes can be seen to be lower primarily on the Southeast Expressway, Albany Street, Dorchester Street, Morrissey Boulevard and Berkeley Street, again summing up to about 20,000 vehicles per day.

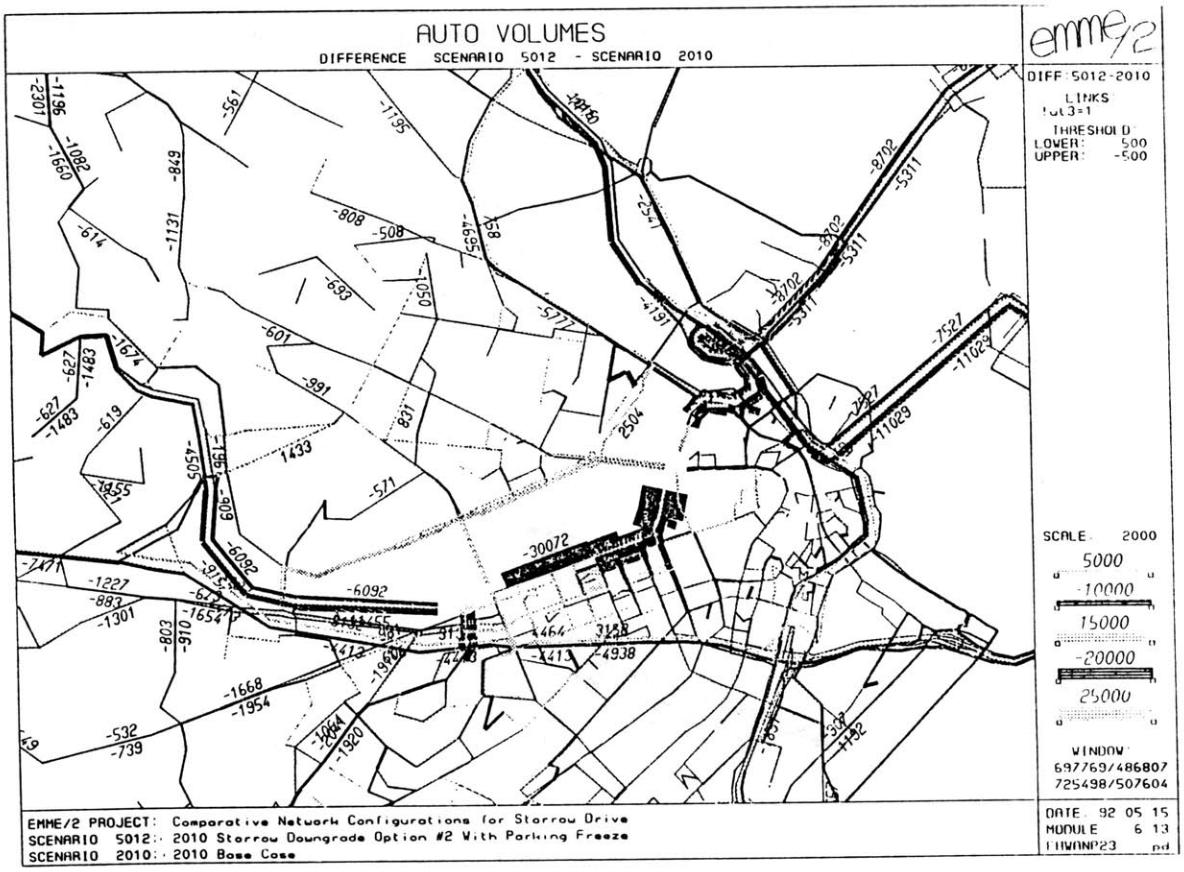


Figure 5.2-1. 2010 Ext. Core AWDT Volume Comparison: Parking Freeze - Base Case.

At the same time, the shifts associated with downgrading Storrow Drive are still visible through increases in Memorial Drive traffic and the associated increases in bridge volumes across the Charles River. In Cambridge, the reductions are generally more scattered throughout the area, while in downtown Boston, due to the very high number of trips ends, the effects of parking freeze are quite visible in that volumes on a majority of city streets decrease by one to several thousand vehicles per day. Volume decreases at the peripheral locations are again listed in **Table 5-A2** in the and for locations along the screen ring in **Table 5-A3** in the appendix.

5.2.3.2. Study Area

From **Figure 5.2-2** it appears that the parking freeze has the effect of uniformly reducing vehicle trips throughout the Back Bay. When compared to **Figure 4.3-4** it can be seen that the Back Bay traffic redistribution pattern due to the downgrading of Storrow Drive is still visible under a parking freeze. Nevertheless, and as expected, increases compared to the base case on East-West arterials are much smaller and decreases on North-South arterials much larger than for the MED SCHEME. Large reductions can be seen for the area to the South and West of the Boston Common, with the largest decreases occurring on Arlington and Beacon Streets.

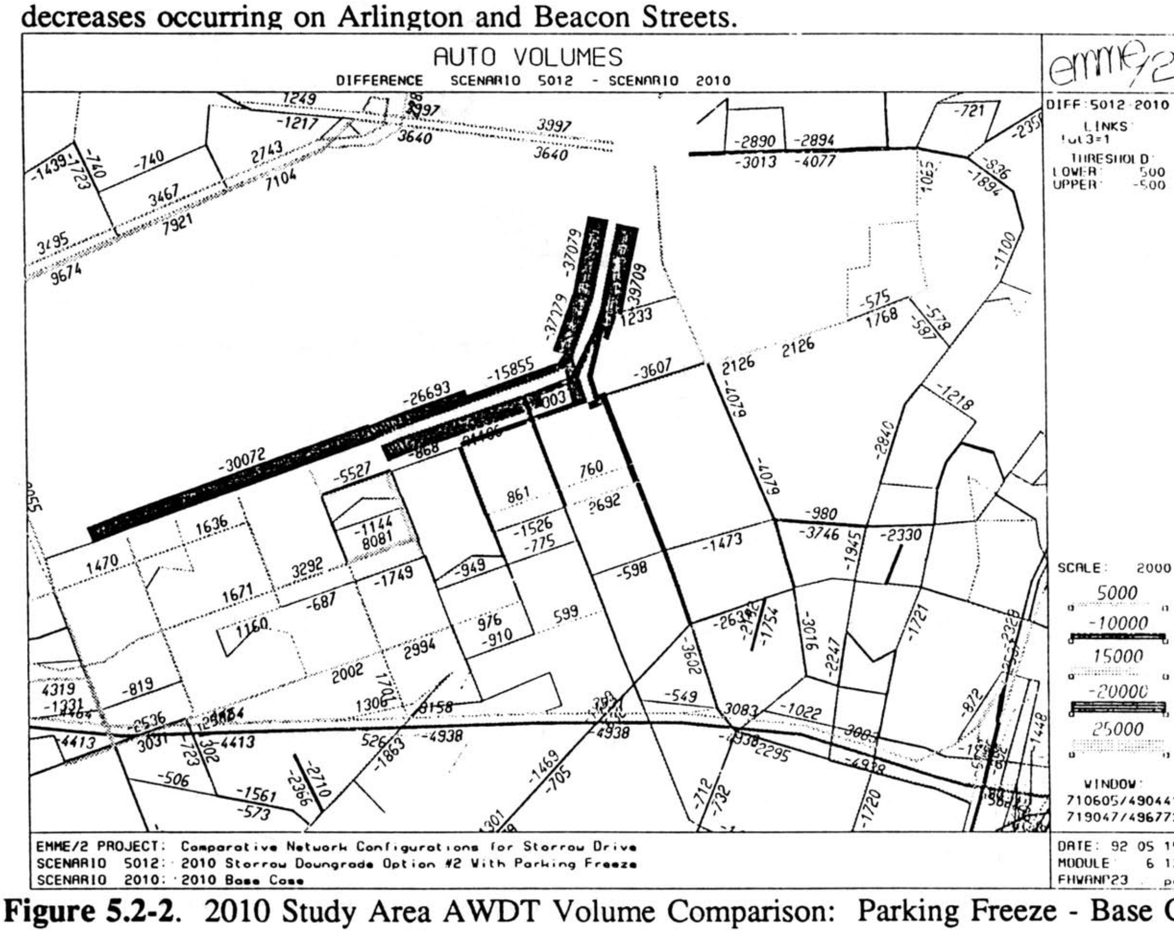


Figure 5.2-2. 2010 Study Area AWDT Volume Comparison: Parking Freeze - Base Case.

The sensitivity analysis performed here, although based on some broad assumptions, is useful to get an idea of the traffic impacts of a parking freeze. It could be seen that a parking freeze which is enforced in Boston and Cambridge would reduce vehicular traffic in the subregion by a total of about 200,000 trips or almost 7%. This, and the fact that the parking fee represents the majority of the out-of-pocket cost for each individual trip by automobile,[141] underlines how powerful the application of this policy tool is in terms of restricting the use of the automobile.

5.2.4. Policy Implications

Parking restrictions play a special role in the general policy arena of urban transportation. Investments in transit projects, although "paramount to insure high transit ridership"[142] will not result in envisioned ridership volumes as long as parking is amply available. New transit systems, such as the San Diego Trolley and Washington's Metro, attracted a relative minority of riders who were previously automobile users partially because there were no concurrent parking restrictions imposed in these cities.[143] Therefore, there should be a direct link between parking policy and improvements in public transportation services, as will be dicussed later in this paper.

The State of Massachusetts is *committed to a parking freeze* through a binding agreement with the Conservation Law Foundation which was drafted in the context of tying a comprehensive, long-range transportation plan to the completion of the CA/T project. This agreement also stipulates that capacity of highway facilities should not be increased along radial corridors. It has been shown that a parking freeze would be one of the most effective measures to achieve this obvjective.

The year 2010 trip tables used for traffic analysis in this paper do not reflect this presumption of a parking freeze and probably overstate the number of auto trips which would actually occur in Boston in the year 2010. The projected massive increases in volumes by the year 2010, as discussed in Chapter 1.2, are evidence that the no-policy assumption underlying the generation of trip tables would lead to greater traffic levels than could be absorbed by the raod system. Traffic assignments from above utilizing a reduced trip table might therefore more accurately reflect lower future travel volumes which would be achieved through the enforcement of a parking freeze.

The trips which would be diverted from the automobile could largely be absorbed by the existing and expanding transit system. An example of a possible transit improvement which would help support a parking policy as put forward in this section is discussed below.

5.3. Building Circumferential Transit (CT)

Up to this point, the discussion of possible transportation "mitigation" has focussed primarily on how to affect specific travel choices of automobile users through policies which aim at either shifting routes of travel (Turnpike upgrade) or discouraging automobile use within the city (parking freeze). Policies which are designed to discourage automobile use are most effective if viable alternatives are supplied. Boston already has a dense and functioning public transportation system. In this chapter I discuss how the building of circumferential transit is one possible option to increase the number of transit alternatives and improve transit connections between areas in the city which are currently not so well served.

5.3.1. Policy Elements and Objectives

In early 1987, the Massachusetts Bay Transportation Authority (MBTA) initiated a Circumferential Transit Feasibility Study to examine long range options for improving access to areas outside of the regional core and relieving congestion in downtown Boston on the radial rapid transit system.[144] Like many other major metropolitan areas, Boston has several large activity centers located outside of the central core which generate substantial numbers of trips. Considerable development has occurred along a circumferential corridor about 10 miles from downtown as a consequence of access facilitated by the completion of Route 128. A second ring, immediately surrounding the downtown employment core, contains several large and growing activity centers including the following:

- South Boston Piers,
- University of Massachusetts/Harbor Point,
- Newmarket Area,
- Boston City Hospital/Boston University Medical School/Southeast Technology Square,
- Southwest Corridor Redevelopment Area,
- Northeastern Unversity,
- Longwood Medical Coplex,
- Boston University,
- University Park Simplex Development (Cambridge),
- Massachusetts Institute of Technology,
- Kendall Square,
- East Cambridge Redevelopment Area,
- Lechmere/North Point Redevelopment Areas,
- Bunker Hill Community College,
- Charlestown Navy Yard,
- Everett/Chelsea Industrial Area
- Chelsea Waterfront, and
- Logan Airport.[145]

The existing transportation system serving the circumferential corridor consists primarily of the regional transit and highway networks which radiate from the Boston core area. While three interstate highway segments, numerous expressways and arterials and all of the MBTA's rapid transit and commuter rail lines cross this corridor, no major highway or rapid transit line connects activity centers in the corridor. In fact, Storrow Drive carries many of these trips between circumferential acitivity centers. As a result, highway access requires travel to the core of Boston and then back out on very congested facilities, or traversing the corridor on generally local streets which carry volumes well beyond their design capacities. Travel by transit is equally troublesome. Most transit trips to activity centers located within the corridor require riders to use radial lines and to pass through or transfer at the most congested points in the system. Alternatively, travel between points in the corridor can be made by bus, but these routes tend to be slow and unpredicatble as a result of the congested street segements over which they must operate.[146]

Boston is unique in the density and level of employment activity contained in these close-in centers. However, neither the capacity of the regional highway network and local arterial system nor the radially oriented rapid transit system appears to be sufficient to serve these areas in the long run. It was these considerations which prompted the MBTA to formulate the following objectives as part of their circumferential transit study:

1. Improved access to and between major activity centers in the fringes of downtown Boston and the ten surrounding cities and towns.
2. Improved access to intercity and regional services such as the Northeast Corridor Rail, commuter rail, and air transportation.
3. Relief of crowding in the central segments of the Green Line and the radial rapid transit lines such as the Red and Orange Lines.
4. Increased overall ridership on the MBTA system.[147]

Proposals for a similar form of transit service date back as far as the Boston Transportation Planning Review (BTPR) of 1972 which identified a primary service corridor encompassing much of the area envisioned for what was then the recently abandoned Inner Belt Highway. A conceptual plan of connecting key activity centers in an intermediate ring from the core was developed by the BTPR and is depicted in **Figure 5.3-1**. These ideas were taken further in 1976 with the Program for Mass Transit (PMT) which suggested a similar alignment for a possible circumferential transit service and appear today in such proposals as the City's "Bioscience Line."[148]

In order to test the impact of the construction of a circumferential transit system on automobile travel in the network, Alternative 3D is selected. This alternative includes a core light rail transit (LRT) segment between Ruggles Station on the Southwest

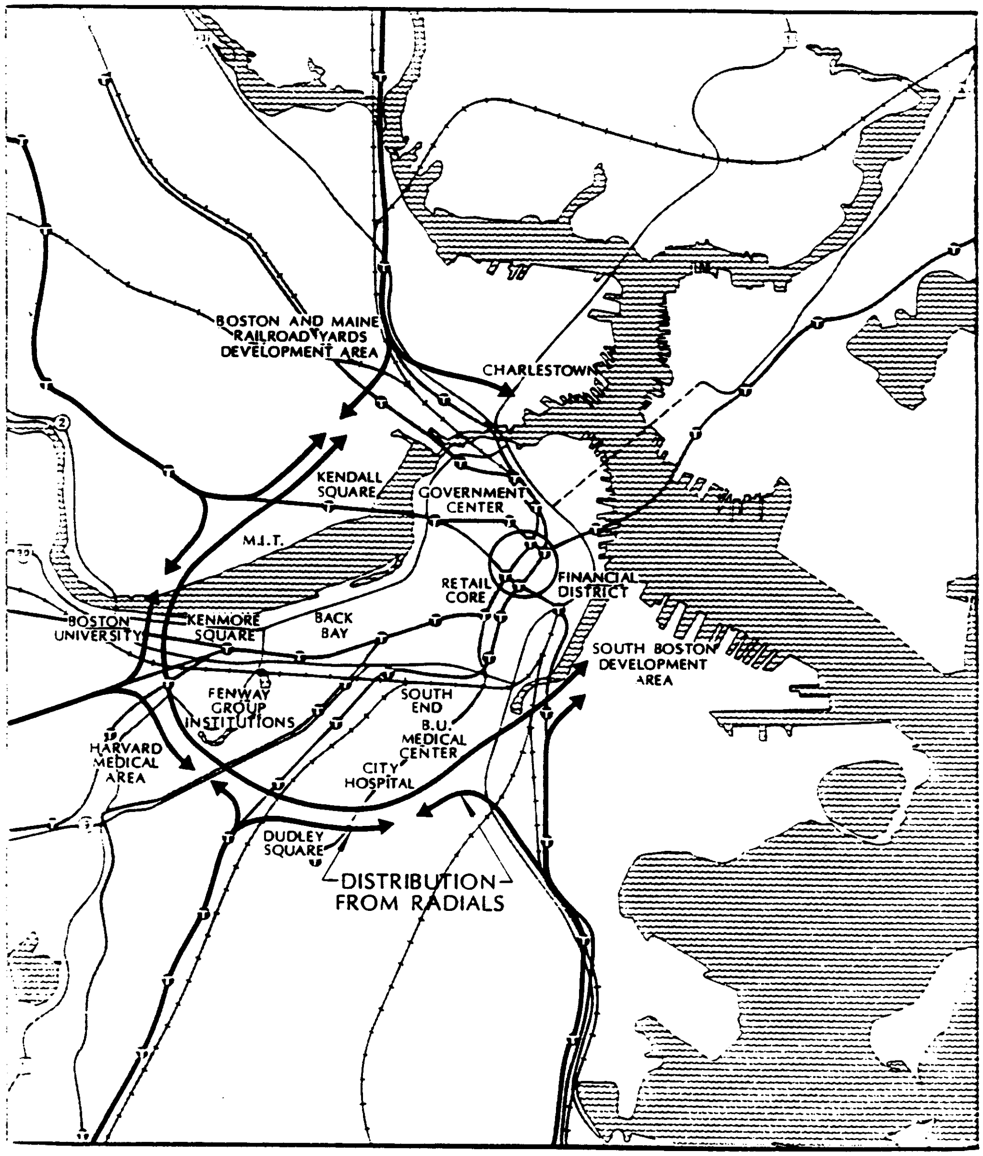


Figure 5.3-1. Circumferential Transit Concept Plan developed by the BTPR, 1972.

Corridor/Orange Line to Community College Station on the northern leg of the Orange Line and adds an extension from Ruggles to the JFK/U Mass Station on the Red Line as illustrated in **Figure 5.3-2**. Because of lower ridership demand on the outer portions, two light rail lines would be operated, one running from JFK/U Mass to Kendall Square, and one connecting Ruggles Station to Community College. In the highest demand segment between Ruggles and Kendall the lines would be concurrent serving riders at double frequency.

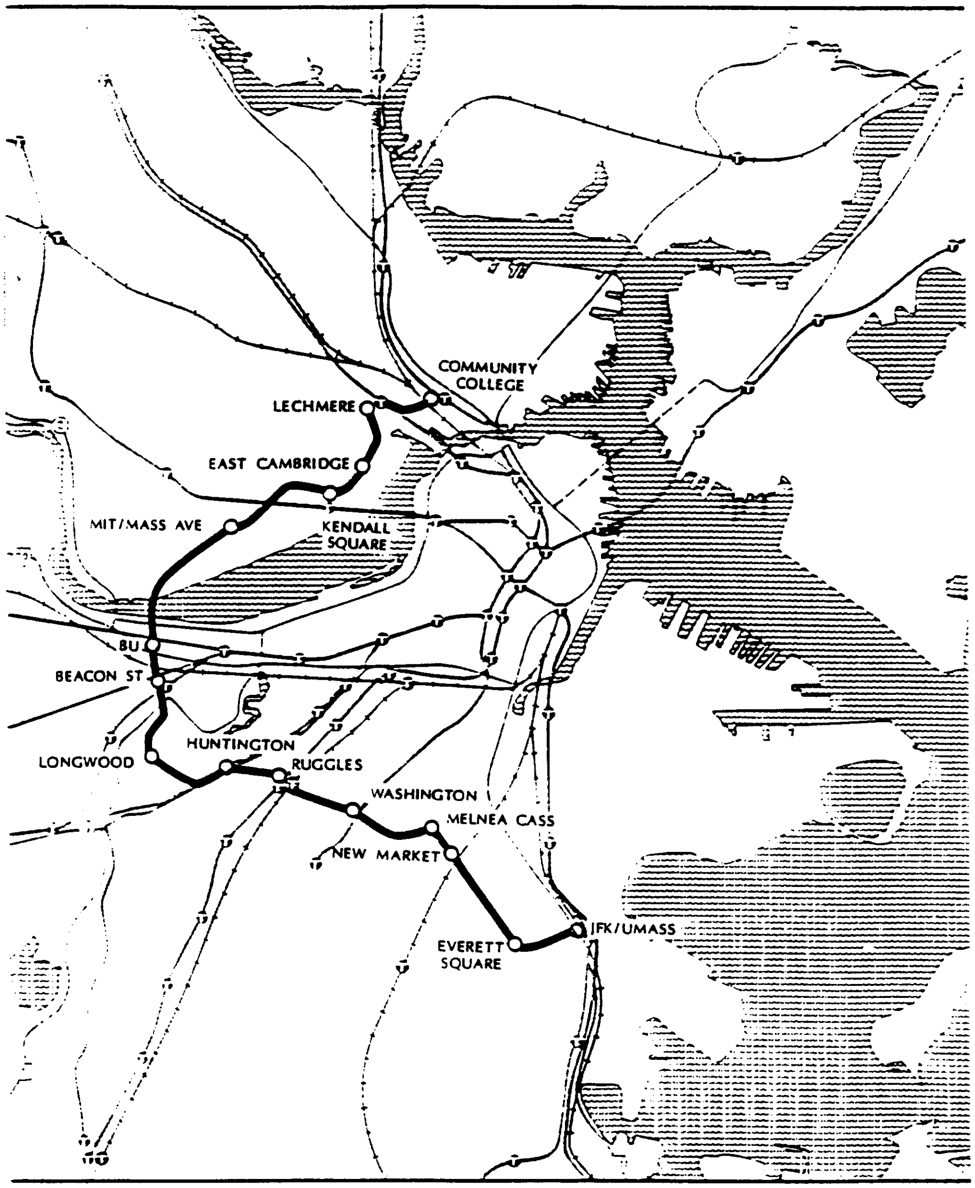


Figure 5.3-2. Alignment of Circumferential Transit, Alternative 3D.

5.3.2. Model Representation

How effectively would the construction of a circumferential transit system be in reducing trips by automobile in the subregion? **Table 5.3-1** shows a summary evaluation of various long range alternatives for the circumferential corridor.[149] It can be seen that for those alternatives including a light rail transit (LRT) segment, regional vehicle travel (VMT) is estimated to be reduced by about 400,000 miles per day.

TABLE IX-1

Year 2010
Long Range Alternatives Summary Evaluation

Criteria	2 TSM	3C Core LRT	3D Core LRT (JFK/U Mass)	3E LRT (JFK/U to Airport)
Daily Corridor Ridership	9,000	102,000	120,000	148,000
Daily System Wide Ridership Compared to 1987	+ 215,000	+ 275,000	+ 277,000	+ 287,000
Travel Time Savings Compared to Baseline Alternative	157,000 min./day	749,000 min./day	842,000 min./day	1,137,000 min./day
Service to Users With Special Needs	Minor Improvement	Major improvement if Green Line is made accessible.	Major improvement if Green Line is made accessible.	Major improvement if Green Line is made accessible
Reliability	Fair to poor	Good	Good	Good
Implementation	Simple improvements, easily undertaken	Major project, no new technology.	Major project, no new technology, can be phased.	Major project, no new technology, can be phased.
Change in Regional Vehicle Travel Compared to Baseline Alternative	- 24,000 miles/day	- 379,000 miles/day	- 385,200 miles/day	- 465,000 miles/day
Noise Impacts	Increased diesel bus operations.	Little or no change with mostly subway operation.	Minor increase on surface segments.	Minor increase on surface segments.
Land Use Impacts	None	Major influence in core segment.	Major influence in core segment, stimulus for development on outer links.	Major influence in core segment, stimulus for development on outer links.
Social Impacts	Minor positive benefit.	Major service improvement to low income neighborhoods and employment opportunities.	Major service improvement to low income neighborhoods and employment opportunities.	Major service improvement to low income neighborhoods and employment opportunities.
Corridor Capital Costs (1988 $)	$19,000,000	$1,033,000,000	$1,245,000,000	$1,370,000,000
Annual Operating Costs Compared to Baseline Alternative (1988 $)	+$17,000,000	- $4,000,000	- $10,000,000	- $1,000,000
Cost Effectiveness (Standard Federal	Base for	$3.78	$4.18	$4.26

Table 5.3-1. Summary Evaluation of Long-Range Alternatives (Year 2010).

Conventional CTM analysis following the four-step trip generation - trip distribution - modal split - route choice approach would estimate the ridership impacts of new transit service through a comparison of the convenience of using the car versus using transit to reach certain destinations. Through the changes of variables such as travel time afforded by new transit service, the modal split analysis would estimate for how many people transit would now be preferred to auto.

Since in this paper the trip tables are fixed, a simplified approach to replicate the results of a modal split analysis are performed. For the purpose of showing how this estimated reduction would be reflected in network volumes, the following procedure is adopted and explained below:

1. Estimate ridership on circumferential transit system for year 2010.
2. Disaggregate to find year 2010 circumferential boardings *by station.*
3. Allocate station boardings proportionally to corresponding MDPW zones according to shortest walking access distances and zonal trip origin volumes.
4. Adjust these zonal new transit origins by a factor which accounts for the increase in trip linking.
5. Assume that all new linked system trips which are not diverted from other transit modes are diverted from automobile.
6. Assume an average vehicle occupancy of 1.2 persons per car.
7. Subtract new transit trips from the sum of auto trips originating at those zones.
8. Proportionally distribute reduction of trips from specified origin to all its destinations.

The consulting firm's estimate of circumferential ridership in the year 2010 for Alternative 3D is slightly above 120,000 passengers per day and station boardings are distributed as shown in **Table 5.3-2**. In order to estimate which zones would profit most from this new service, a traffic zone map illustrating which zones are covered within the area of a 10-minute walking radius from each station is presented in **Figure 5.3-3**. Based on geometric overlap and the total volumes of trips originating from the zones adjacent to a new station, a rough estimate of station boardings by MDPW zone is derived and listed in **Table 5-A5**. Subsequently, this number is adjusted to account for the fact that while systemwide *unlinked* trips increase by 124,000 over the 2010 baseline, the increase

	Alternatives				
	3C	3D	3E	3F	5D
JFK/U Mass	---	7,120	9,250	10,150	---
Edward Everett Square	---	2,820	3,270	3,200	---
Newmarket	---	1,500	1,660	1,580	---
Melnea Cass/Mass. Ave.	---	3,220	4,390	4,130	---
Melnea Cass/Wash. St.	---	2,910	3,700	3,430	---
Ruggles	14,680	18,070	16,760	15,660	14,570
Longwood/Huntington	8,410	9,190	8,890	8,380	8,420
Longwood/Brookline Ave.	11,140	12,180	11,790	11,110	11,160
Park Drive/Beacon Street	8,750	9,220	10,300	7,800	8,770
Boston University	13,990	14,460	15,560	12,660	13,980
MIT/Mass. Ave.	10,780	10,940	11,410	---	10,810
Kendall Square	16,960	14,130	16,890	---	17,380
East Cambridge	2,680	2,360	2,950	---	2,690
Lechmere	3,860	3,130	4,050	---	3,760
Community College	10,940	9,120	6,850	---	11,690
Main St./Vassar St.	---	---	---	7,780	---
Cambridge Street	---	---	---	2,150	---
Brickbottom	---	---	---	5,350	---
Sullivan Square	---	---	8,030	15,640	---
Rev. Beach Parkway	---	---	3,820	2,890	---
Mystic Mall	---	---	1,530	1,490	---
Chelsea/Broadway	---	---	4,450	2,990	---
Logan Airport	---	---	2,670	2,700	---
TOTAL	102,190	120,340	148,230	119,050	103,210

Table 5.3-2. Year 2010 Circumferential Transit (CT) Station Boardings.

in *linked* trips is only 67,000, as seen in **Table 5.3-3**. This reflects the assumption that many circumferential riders will also use other parts of the transit system to use their destination. Therefore, the adjustment factor reflects the availbility of alternative transit mode in the proximity of the originating station as shown in **Table 5.3-3**. In order to translate these zonal new transit trip origins into a number of modally diverted auto trips, an average auto occupancy factor is applied and then the trip reduction distributed equally over all *auto* destinations "served" by that particular origin using a C-program which can be found in **Table 5-A5** in the appendix.

The expected reduction of trips would be 67,000/1.2 = 56,000 which, as can be seen in **Table 5-A5** is fairly well replicated by the model.[150] This number (67,000) corresponds to a diversion factor from non-transit[151] of 56% which lies above the factors with transit projects such as the San Diego Trolley with 44%, Washington DC's Metro with 38% and San Francisco's BART with 54%.[152] The diversion rate *from automobiles* in those cases, however, was as low as 28% which is only half the rate estimated in this report where all non-transit diversions are assumed to stem from automobiles.

Figure 5.3-3. Traffic Zone Coverage of 10-minute Walking Radius From CT Stations.

While the examination of the accuracy of any of the estimates adopted from the report[153] is not the object of this study, it should be kept in mind that the trips tables used for analysis here might represent an upper estimate of potential automobile trip reductions. On the other hand, as was pointed out in Chapter 6.2, the linkage of the transit improvement to an enforced parking freeze could possibly yield much greater diversions from automobiles than has been the experience in other cities.

TABLE IX-4
Daily Year 2010 Ridership
(Unlinked Trips)**

Alternatives		MBTA System (Linked Trips)*	Circum-ferential Corridor	Green Line	Red Line	Blue Line	Orange Line	Commuter Rail	Bus System
1987 System		601,000	0	195,000	178,000	44,000	144,000	65,000	362,000
1	Baseline	811,000	0	270,000	257,000	57,000	186,000	91,000	430,000
2	TSM	816,000	9,000	261,000	254,000	57,000	187,000	92,000	440,000
3C	Core LRT (Ruggles to Community College)	876,000	102,000	254,000	265,000	59,000	199,000	109,000	427,000
3D	LRT (JFK/U Mass to Community College)	878,000	120,000	252,000	261,000	59,000	201,000	110,000	412,000
3E	LRT (JFK/U Mass to Airport via Community College	888,000	148,000	250,000	261,000	52,000	196,000	112,000	392,000
3F	LRT (JFK/U Mass to Airport via Grand Junction Railroad	879,000	119,000	256,000	261,000	54,000	201,000	109,000	408,000
5D	Mini Metro (Ruggles to Community College)	877,000	103,000	254,000	265,000	59,000	199,000	109,000	427,000
6	Guided Bus (JFK/UMass to Airport)	835,000	114,000	231,000	250,000	48,000	191,000	102,000	492,000

* Linked Trips are the total weekday trips made on the MBTA system; thus, a trip involving transfer from the Orange Line to the Red Line counts as only one linked trip.

** Unlinked Trips are the total average weekday passenger trips on each line or mode; thus, a trip involving a transfer from the Orange Line to the Red Line counts as one trip on each line.

Table 5.3-3. Daily Year 2010 CT Ridership: Unlinked Trips.

5.3.3. Traffic Impacts

One would expect that the shifting of 56,000 trips from auto to transit in a network which carries more than 3,000,000 vehicles daily will not result in any substantial changes of particular link volumes. Whether the reduction of system auto trips by 1.5% will visibly decrease traffic on any link within the network is the subject of analysis below. It should be noted that for this chapter, all comparisons are performed relative to the MED SCHEME rather than the 2010 base case because this comparison will make it easier to locate where the smaller reductions in traffic volumes will occur.

5.3.3.1. Extended Core

As could be seen in **Figure 5.3-4**, there is a slight reduction in volumes on links connecting the network with zones adjacent to the newly created stations. Some of these are:

- Several streets in Charlestown carry fewer vehicles as a consequence of the new connection to circumferential destinations at Community College,
- Roadways leading to and in the vicinity of the two Circumferential Transit stops at Lechmere and East Cambridge show similarly lower traffic volumes, as do those close to MIT and Kendall Square,
- Commonwealth Avenue and Beacon Street lose some traffic due to the two new stops at BU and Park Drive,

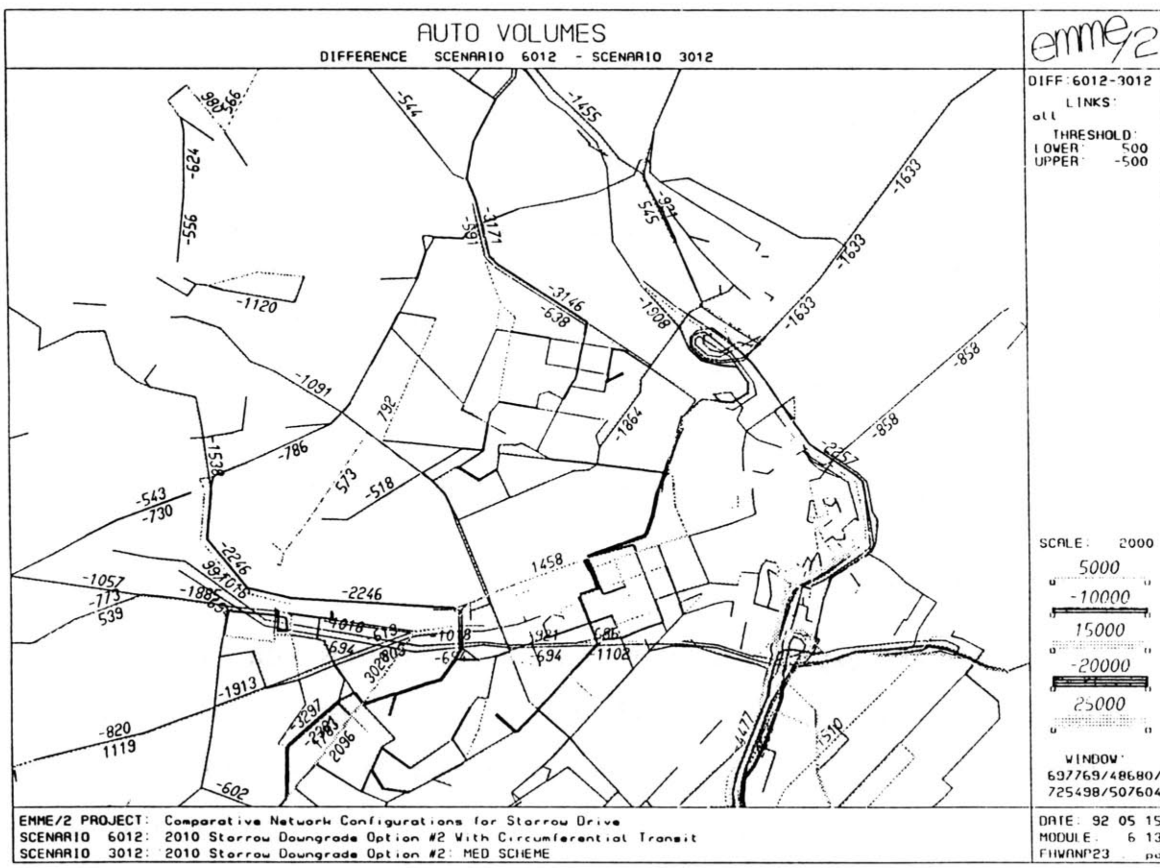


Figure 5.3-4. 2010 Ext. Core AWDT Volume Comparison: Circumferential - Base Case.

- The better transit connections in the Longwood area have comparatively major effects on volumes on Boylston Street, the Riverway and even Route 9 from the Southwest,
- A major travel path between the Longwood area and Cambridge has significantly reduced volumes on a corridor marked by Huntington Avenue-Dartmouth Street-Storrow Drive-Longfellow Bridge/Charles River Dam because of a viable transit alternative with the Circumferential,
- In the Southeast link volume reductions are spread out over arterials such as Massachusetts Avenue, Southampton, Albany and Washington Streets, all of which serve areas which would be connected to the new transit line,
- In addition, the Southeast Expressway loses some vehicles which were headed north to reach Charlestown, Cambridge or points west via the Turnpike.

For a more detailed comparison, assignment volumes at peripheral spot locations and sreen "ring" volumes are shown in the **Table 5-A2** and **Table 5-A3** in the appendix. The *increases* on links shown on in **Figure 5.3-4** are the result of an assignment process allocating volumes according to initial link impedances and a volume-delay function which calculates an approximate additional delay for a link traversal as its volume increases. Therefore, a travel path which contains a section of a congested link will be used more as congestion on such a link is reduced through the Circumferential Transit diversion effect.

5.3.3.2. Study Area

While no new transit connections are established within the downtown, Back Bay and Beacon Hill area, reductions in traffic volumes on their roadways do result from decreases in through traffic. These are a direct result of the created availablity of better transit services in the corridor surrounding the central area. **Figure 5.3-5** shows changes in link volumes in the Back Bay and Beacon Hill:

- The most dramtic decrease is along a path via Storrow Drive-Dartmouth Street-

Commonwealth Avenue-Exeter Street-Huntington Street which serves as a major connection between Charlestwon/Cambridge and points south of the Turnpike, such as the Longwood Medical area,

- The reduction offsets an increase along this corridor caused by the downgrading of Storrow Drive and a shift of the Arlington off-ramp to Dartmouth Street,
- Additional decreases are seen on Berkeley and Arlington Streets, the former possibly resulting from a reduction in trips between the South Bay area and Cambridge, the latter from a reduction in return trips via the Longfellow Bridge,
- Decreased volumes on the Boylston-Charles-Beacon-Bowdoin path is possibly a consequence of reduced trips from Longwood to Cambridge/Charlestown.

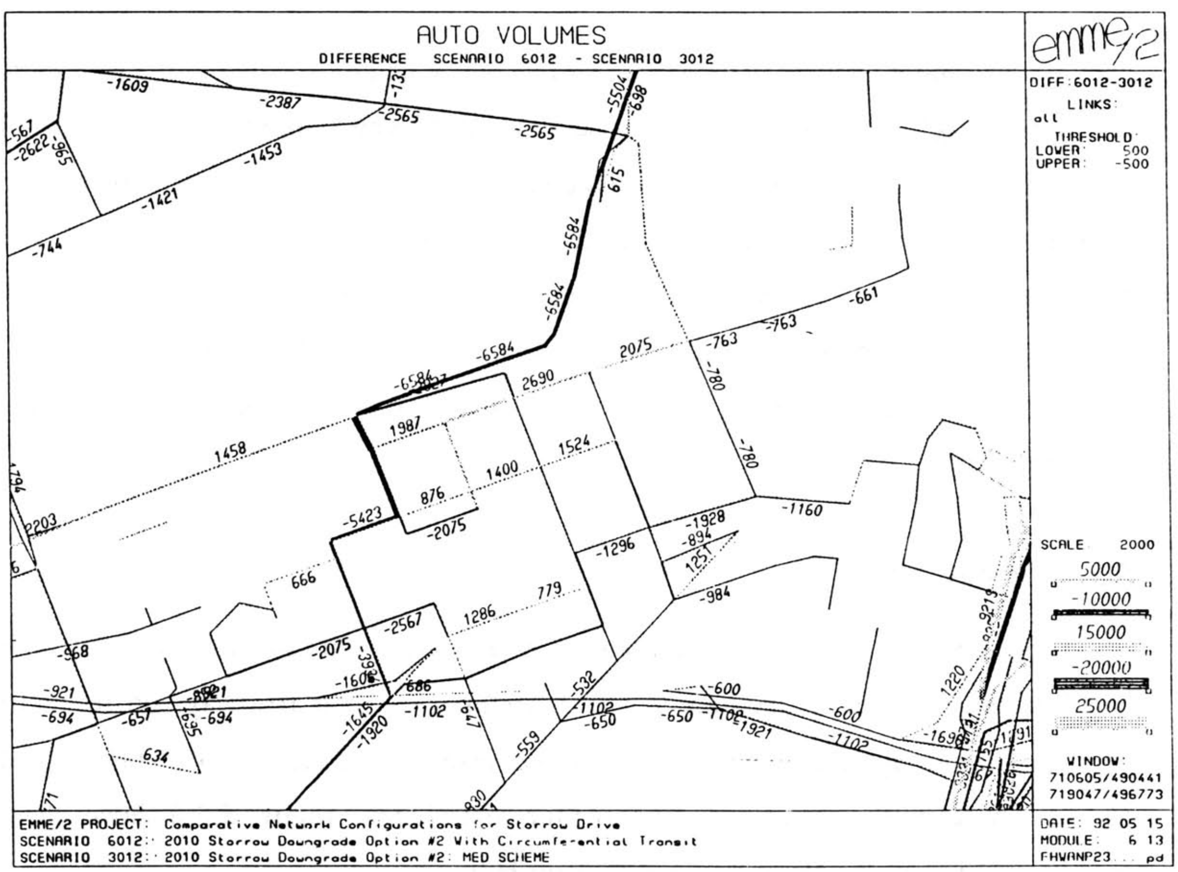


Figure 5.3-5. 2010 Study Area AWDT Volume Comparison: Circumferential - Base Case.

While travel paths can only be accurately determined using a select link analysis,[154] the kinds of trips which are eliminated as a consequence of the Circumferential Transit can be crudely inferred from the changed trip tables. Significant for this analysis is the fact that the circumferential transit service eliminates a fair number of trips crossing through downtown to reach locations along this "activity ring."

5.3.4. Another Transit Opportunity: Extending the Blue Line

Another downtown transit project which has circulated for a number of years is the extension of the Blue Line from its current terminal to the West. A connection of the Red and Blue Lines at Charles Circle was briefly discussed in Chapter 3. The benefit of this project, beyond creating the impetus to restructure the current layout of the traffic circle, lies in the fact that it would connect Cambridge residents to Boston's waterfront and people on the North Shore to MGH, two important transit connections many of which are currently made by car via Storrow Drive.

A Blue Line extension beyond Charles Circle to the West has been seen by many as a useful strategy to creating additional transit capacity parallel to Storrow Drive. In absence of any detailed information on demand characterisitcs or ridership forecasts, this discussion of such an extension is limited to a qualitative assessment of the potential effectiveness of such a project.

The extension of the Blue Line to the West is a centerpiece of the RiverVision/2020 proposal. In this plan, the Blue Line would be constructed in a cut-and-cover operation which would simultaneously lead to a downgrade of Storrow Drive. A different proposal, put forward by Carl Zellner from Bruce Campbell and Associates (BC&A), calls for an alignment under Newbury Street and a connection with the Park Street, rather than the Charles Street Station of the Red Line.[155] The former proposal stresses the need to link transportation projects to the improvement of access to and activity at the riverfront and selects Storrow Drive as the alignment accordingly, while the latter focuses on selecting the alignment which would serve the highest existing demands. The effects of such an extension, however, are quite similar in both cases. A partial list of advantages associated with a Blue Line extension is the following:

- Removes a weak spot in the layout of the rapid rail transit network where the Blue Line terminates in the central area rather than extending through downtown.
- Reduces the number of transfers required at the most crowded downtown stations and the need to use the Green or Orange Line for this connection.
- Creates a parallel transit corridor to the Green Line thereby circumventing a standing bottleneck and relieving central tunnel congestion on the latter.
- Increases transit accessibility and capacity near activity centers in the Back Bay which will experience susbtantial growth over the next years.
- Provides better transit access to Logan Airport from the Beacon Hill and Back Bay neighborhoods as well as from points west.
- Improves service for North Shore residents and increases ridership on the Blue Line which is currently underutilized during most hours of the day.
- Generates the potential for a Blue Line-Green Line connection with the Riverside branch, thereby further increasing the connectivity of the transit system.

While no ridership estimates were prepared for either proposal, it is evident that the impacts could be substantial. These proposals are in line with plans to redesign the transportation node at Kenmore Square and greatly improve transit access to and from the Back Bay as well as points to the West. In this regard, the project, if implemented, could provide an effective transit alternative for some who currently use their cars on Storrow Drive. This implies that the Blue Line extension could be applied as a complementary measure to downgrading Storrow Drive, either, as envisioned in RiverVision 2020, through joint development, or, as in the BC&A proposal, by diverting automobile trips to a created transit alternative.

5.3.5. Policy Implications

In Boston, several transit proposals are currently pending. The construction of Circumferential Transit has its rationale in serving a number of large and rapidly growing activity centers in the vicinity of downtwon Boston. A transit line connecting these activity centers with each other and with the rest of the transit system would not only reduce the number of vehicles trips on congested roads in the Back Bay, Cambridge and Charlestown but also foster a development pattern which places jobs near to its workers. In terms of minimizing vehicle trips in the metropolitan area, this kind of pattern is much preferable to the sprawled developments along Route 128 which are very difficult to serve by mass transportation.

Similarly, an extension of the Blue Line to Charles Circle or through Beacon Hill and the Back Bay to points West is compatible with the notion of locating transit near current and emerging employment centers in the vicinity of the core. Improving rapid rail connections to and from the West is an important and timely decision and could be seen as an effective way to bring pedestrians into the vicinity of a downgraded Storrow Drive and enlarged Esplanade.

While no individual transit project is likely to significantly reduce the number of automobiles using the highways and surface roads in the region, the cumulative effect of a continuous upgrading of transit service and a parking policy committed to reducing inner city congestion, could have a multiplier effect of increasing the number of people who would switch to transit compared to an isolated policy approach which does not recognize these systems relationships. A parking freeze has already been committed to be the state and circumferential transit is likely to be built in the near future. Some kind of Turnpike upgrade, in spite of its problems, could also become a reality as the addition of ramps and upgrade of commuter rail in the Kenmore area are vigorously pursued by the city.

The sensitivity analysis of this chapter has given some idea of how automobiles would respond to the application of any of these measures. A balanced approach to urban transportation planning, including measures to improve transit, restrict parking —which the State has already committed to — and divert traffic, could help to promote or complement the urban and environmental objectives which the Storrow Drive downgrade seeks to achieve.

Chapter 6
Compatibility and Implementation

The environmental enhancement facilitated by a diversion of traffic from the river arterial and creation of a more pedestrian-oriented and contextually integrated connection between the BackBay/Beacon Hill and the Esplanade could be a step forward in neighborhoods reclaiming urban spaces lost over the past decades. A variety of redesign options was presented in Chapter 3 to provide a framework for discussion of the form in which such changes could occur. Using standard network equilibrium techniques, analysis in Chapter 4 estimated the transportation "price tag" of various downgrading schemes in terms of changes in the spatial distribution of traffic volumes. Three different policy proposals, put forward in Chapter 5, then addressed the question of how effectively certain measures could aid in mitigating traffic impacts associated with a reduction of capacity on Storrow Drive.

The logical next step is an examination of which factors will determine whether any of these visions could be translated into reality. Are the examined options linked to other on-going projects? How well would these schemes be received by those residing in the vicinity of Storrow Drive? To which extent is the downgrading of Storrow Drive compatible with city and state policy?

Finally, the relevance of the immanent construction and completion of the CA/T project and the recent passage of the Intermodal Surface Transportation Efficiency Act (ISTEA) in terms of providing the necessary momentum for environmental improvements is discussed. These events are a unique opportunity to transform Boston's cityscape far beyond a downgraded Storrow Drive.

6.1. Linkages Among Objectives

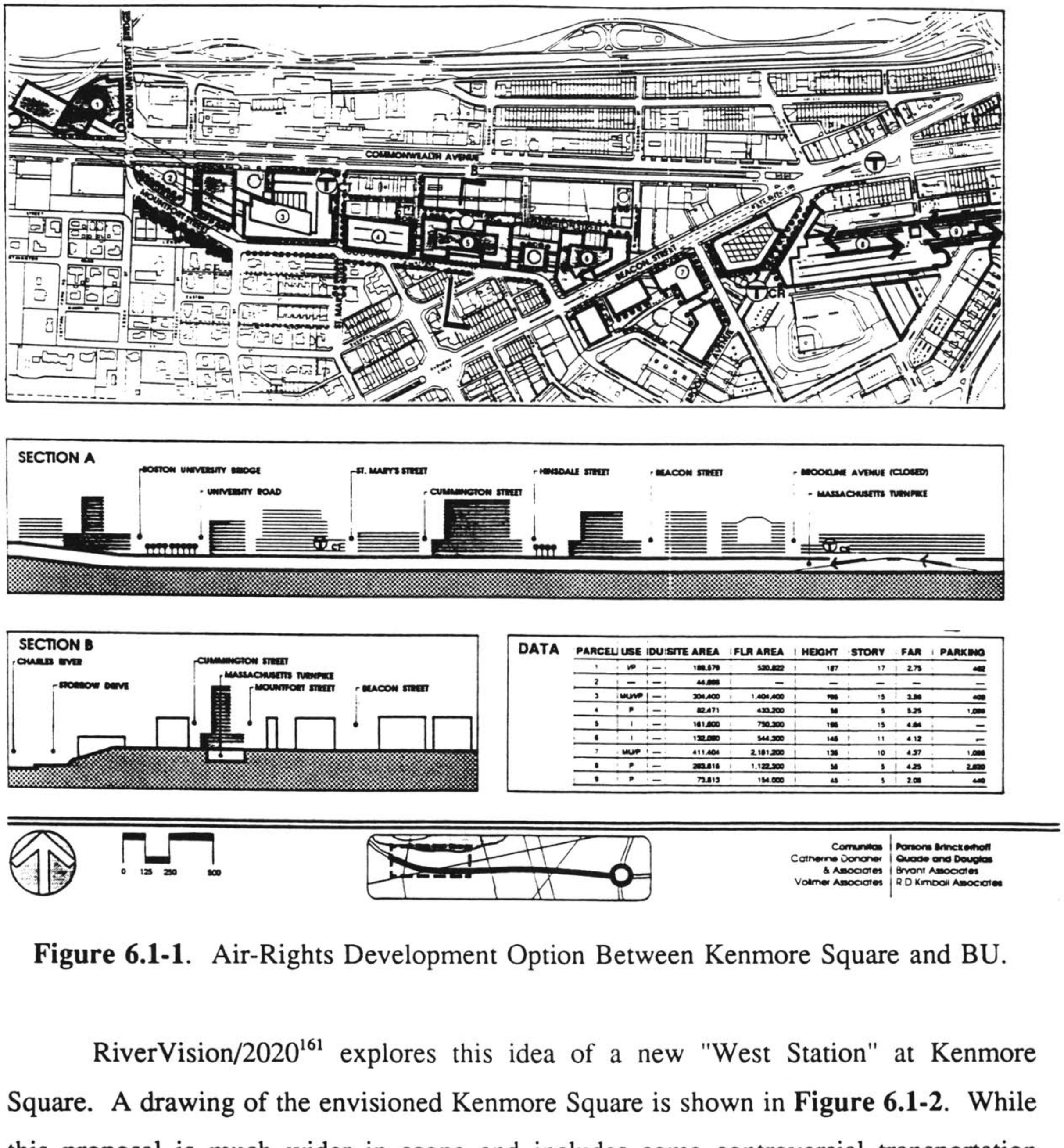
The discussion of options to modify the layout of Storrow Drive in order to improve accessibility to the Esplanade, stressed the systems linkages between various components of a downgrading effort. In this section, the systems approach is taken to the level of policy making. What is a) the logical connection between elements of the downgrading schemes and existing policy objectives, and b) the extent to which different policies are complementary?

6.1.1. Linkage 1: Mass Turnpike, Circumferential, Kenmore Square, Charlesgate

The environmental damage created at Charlesgate be the construction of the interchange has been described in detail in Chapter 2.3. The improvement of Storrow Drive associated with a reduction in capacity included plans for the reclamation of open space at this location. Linked to this reconstruction are related projects in the area.

Studies determining the feasibility of air-rights development over the Boston Extension of the Turnpike commenced in March, 1991, and are now being more concretely discussed with the residents and businesses which are located in its vicinity.[156] The improvement of the pedestrian environment is an integral part of all studied alternatives, as is the addition of ramps in the Kenmore Square area, potentially linked to a large on-site parking facility which should prevent the flooding of local streets by vehicles using these ramps.[157] **Figure 6.1-1** displays one of the development alternatives provided by Comunitas.[158]

The impetus of development in this area could have substantial impacts both in providing an additional rationale for constructing Circumferential Transit — a Circumferential Transit stop is proposed in or adjacent to the Turnpike corridor at St. Mary's Street in all alternatives[159] — and in creating new opportunities for improving the layout of both Kenmore Square and Charlesgate. This linkage was initially discussed in Chapter 3.4. The possible development of an intermodal transportation center at Kenmore Square warrants further study, as proposed by the air-rights study group.[160]



DATA

PARCEL	USE	DU	SITE AREA	FLR AREA	HEIGHT	STORY	FAR	PARKING
1	I/P	—	188.579	520.822	187	17	2.75	[illegible]
2	—	—	[illegible]	—	—	—	—	—
3	MU/VP	—	304.400	1.404.400	[illegible]	15	[illegible]	[illegible]
4	P	—	82.471	433.200	[illegible]	5	5.25	[illegible]
5	I	—	161.800	790.300	[illegible]	15	4.84	—
6	I	—	132.080	544.300	148	11	4.12	—
7	MU/P	—	411.404	2.181.200	136	10	4.37	[illegible]
8	P	—	[illegible]	1.122.300	[illegible]	5	4.25	[illegible]
9	P	—	73.813	154.000	45	5	2.08	[illegible]

Figure 6.1-1. Air-Rights Development Option Between Kenmore Square and BU.

RiverVision/2020[161] explores this idea of a new "West Station" at Kenmore Square. A drawing of the envisioned Kenmore Square is shown in **Figure 6.1-2**. While this proposal is much wider in scope and includes some controversial transportation modification elements such elements as the extension of the Blue Line under a downgraded Storrow Drive, relocation of the Green Line, depression of the Turnpike, as well as the elimination of Storrow Drive between Charlesgate and the Allston Interchange, it has in common with the on-going studies at Kenmore Square the multi-modal transportation node, air-rights developments and ramp additions to the Turnpike.

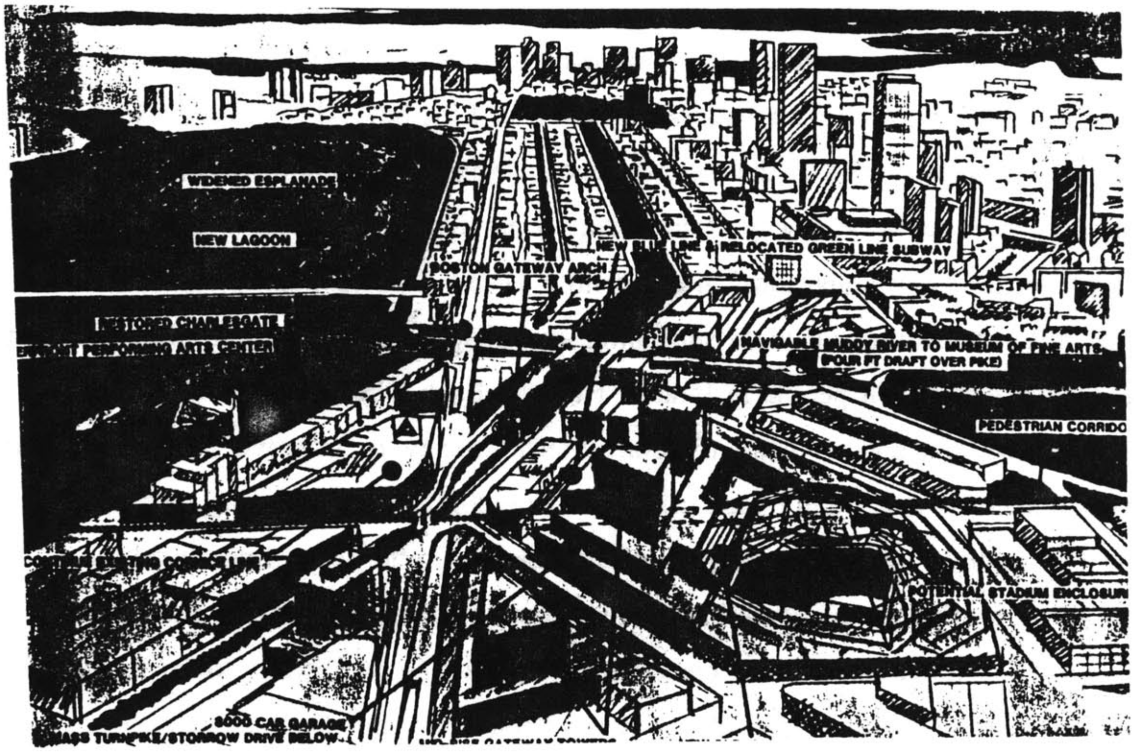


Figure 6.1-2. Kenmore Square Area Development Option from RiverVision/2020.

Although there are differences in the objectives for the RiverVision/2020 and air-rights plans, the desire to restore the ground level for pedestrians, bridge the gap created by the Turnpike corridor and upgrade the importance of Turnpike access is expressed in both.

Understanding the linkage between the role of the Massachusetts Turnpike, transit, pedestrian connections, development potential and urban design improvements and their special relationship to improving access to the Charles River are important and complementary investigations to the options put forward in Chapters 4.

6.1.2. Linkage 2: Red Line, Blue Line, Charles Circle, MGH

As was discussed in Chapter 3.2, the connection of the Red and Blue MBTA rapid transit lines has been in the planning books for a decade and is resurfacing in a time where the City is evaluating several rapid transit improvement options for the next decades. As part of the MBTA Capital Construction Program on Future Improvements, it is listed as currently being in the Alternatives Analysis/Draft Environmental Impact Report Stage and expected to be completed by the year 2010.[162] In addition, as was discussed in Chapter 6.3, an extension of the Blue Line beyond Charles Circle to the West should not be precluded by the reconstruction of Charles station. It was reasoned that such an extension could be a way of providing a parallel transit system to the Green Line, therefore reducing congestion in the central Green Line tunnel.[163] It was also argued that this extension could yield substantial benefits in creating a more direct connection to Logan Airport for people in Beacon Hill, the Back Bay and points West.

The concept of using (federal) transit money to improve parts of the urban environment is one widely used in RiverVision/2020. This financing mechanism could be well applied for the reconfiguration of Charles Circle. In a time where the MDC is planning to finance a rebuilding of the existing ramps leading to and from Charles Circle[164] it should be seriously considered whether it is worthwhile to invest this money at a location where a joint Bowdoin/Charles connection and Charles Circle redesign could be achieved. Experience with the Southwest corridor project, where the relocation and depression of the Orange Line led to the creation of an extremely popular linear park, shows how successfully joint planning can produce pleasant environments.[165]

A second impetus for both building the transit connection and/or extension and the redesign of Charles Circle could come from development at Massachusetts General Hospital (MGH). Being the largest employer in Boston, save the city itself, MGH has recently purchased the old Suffolk County Jail which is surrounded by a high wall and directly abuts Charles Circle. The jail's conversion to a building accessible to the public and the simultaneous opening of the northwest corner of the square towards Cambridge Street and the Esplanade, as discussed in Chapter 3.2, could contribute significantly to creating some impetus for modifying the existing traffic circle. In addition, as has also been decribed, the possible reconstruction of the MGH parking garages as underground facilities creates several possibilities of underground access which could be jointly developed with the Charles Circle underpass as proposed in Chapter 3.

This shows that rethinking what Charles Circle could look like and considering the access potential, both in terms of an improved transit connection and an enhanced pedestrian environment is both reasonable and timely. Its location at an important future transit node and adjacency to the largest employer and most popular park make Charles Circle a prime candidate for improvement.

6.1.3. Policy Interdependences

It was briefly mentioned in Chapter 5 that a parking freeze can help achieve the goal of reducing automobile travel and increasing the use of transit. By the same token, a vigorous transit policy will be most effective if automobile use is restricted at the same time. It can be seen in cities worldwide, that policies aimed at limiting automobile use in order to reduce inner-city congestion are typically linked with a set of complementing measures, such as central parking restrictions and improved public transportation services into and from the core.[166]

Reducing the number of automobiles using the transportation network eliminates congestion and helps accelerate the ease of travel for those more dependent on their automobiles who continue to use them, as well as those who use a mode of public transportation, such as the bus, whose service performance is dependent on the level of congestion on roads.

The construction of circumferential transit would reduce many thousand vehicle trips currently connecting important activity centers surrounding the core. It was shown in Chapter 5.2 that one of the primary beneficiaries of this addition of transit service would be Storrow Drive and ramps connecting to the Back Bay. What the Blue Line-Red Line connection is for Charles Circle, the commuter rail and air-rights developments for Kenmore Square and Charlesgate, the circumferential transit project could be to the Arlington/Berkeley ramp area.

Thus, while the environmental improvements which could be achieved through downgrading Storrow Drive stand on their own merit, they could also successfully tie in with complementary developments at or relating to certain key nodes. They are compatible with federal and state policy which places great emphasis on environmental enhancements in cities. They similarly support the achievement of an agreement between the State and CLF regarding radial capacities and a parking freeze. Furthermore, they would tie in successfully with a circumferential transit plan which is currently in its planning stages. This underlines that the improvement of pedestrian connections along Storrow Drive and enlargement of open spaces through a reduction in the scale of Storrow Drive, could help to actually achieve the objectives pursued by the state.

6.2. Constituency

The weighting of costs and benefits for alternative downgrading options depends on the degree to which the achieved outcome will coincide with broad objectives as formulated by those parties which are affected by any of these options or policy applications. One can distinguish between two kinds of groups which will take a stand on these issues: The first are those people who are directly affected by any physical changes in the environment, such as abutting residents, local merchants, pedestrians, park users, and motorists. The second are those who have professional liabilities through their occupation as policy makers, planners or designers.

The following discussion will highlight which objectives and concerns reflect the attitudes of these groups of actors towards downgrading Storrow Drive and towards the policy applications examined in this context. Published reports as well as information gathered from interviews with representatives of selected planning agencies and citizens groups provide the basis for a synthesis of positions taken on transportation policy questions relating to Storrow Drive.[167] While it does not claim to be complete, the analysis seeks to convey an understanding of the extent of compatibility between some of these interests and the policy goals formulated in this report.

6.2.1. Beacon Hill Interests

One of the older neighborhoods of Boston, Beacon Hill is a small and wealthy residential community which abuts the Esplande — Storrow aside — between Arlington

Street and Charles Circle. Beacon Hill is affected by traffic headed to and from Government Center, the Back Bay, and downtown, and particularly by regional traffic on Storrow Drive, with connections at Charles Circle and Leverett Circle.[168]

Minimize Storrow Traffic. The prevention of an increase in traffic along the Charles River corridor is one of the key objectives of this community. The *Beacon Hill Civic Association* (BHCA), representing residents' interests in Beacon Hill, is one of the principal opponents to improving connections between the Interstate system and Storrow Drive. When more than a decade ago a direct connection from Storrow Drive to I-93 was proposed, called the Leverett Circle Connector Bridge,[169] the BHCA was one of its fiercest opponents.[170] Today, as a participant in the Bridge Design Review Committee's effort to find an improved design for the proposed Central Artery River crossing, one of the key concerns voiced by residents of Beacon Hill is the impact of the Leverett Circle connection on Storrow Drive traffic.[171]

Improve Access to Esplanade. A downgrading of Storrow Drive, with associated improvements for pedestrians and open space, has repeatedly been formulated as an objective in itself.[172] As Peter Thomson, one of the association's representatives and member of BHCA's parking and traffic committee, describes Beacon Hill's view in the controversy surrounding the role of Storrow Drive,

> ".. We must plan highways and cities so they don't take away our most vital resources. We cannot only think in terms of moving cars but need to consider the urban context, [..] think about people crossing the street and bicyclists. [..] The Esplanade is a vital part of the city, and the highway system and Esplanade are inextricably linked."[173]

This statement reflects how the accessibility and beauty of the Esplanade enjoyed by residents is directly linked to the transportation role which Storrow Drive will assume in the future. While the depression of Storrow Drive would appear to serve the neighborhood's interests best in that the smoothest transition between the residential district and the Esplanade could be established, the disruption of traffic and concerns about an impact on the water table could make a downgraded surface version of Storrow Drive appear preferable since there are fewer problems associated with such a redesign efffort.

Maintain Transportation Access. Those residents who currently use Storrow Drive would be affected like all other motorists. Beacon Hill, like any other community, wants good transportation connections to the city. While the loss of capacity on Storrow Drive might stir some opposition, inconveniencing automobile travel to a certain degree is likely to affect people here less than in other communities since Beacon Hill has one of lowest auto ownership and highest transit share rates in Boston.[174] Although regional motorists are not likely to support a capacity reduction, the improvements afforded through the CA/T expansion could act as compensation. MGH, although not strictly part of Beacon Hill, favors an improved and downgraded environment and the associated benefits for patients and employees, but wants to maintain good vehicular accessibility. MGH also supported the Blue Line-Red Line connection some ten years ago, since more than 50% of its 11,500 employees use transit to get to work.[175] For most others, a decrease in automobile accessibility associated with a lower-capacity Storrow should only matter minimally compared with the expected increase in pedestrian accessibility, especially if the improvements are met with the planned Blue Line-Red Line connection.

Minimize Local Traffic. Beacon Hill's local streets are laid out in a manner which makes it virtually impossible to cross through the residential district. Although some circulation improvements have been recommended recently,[176] the minimization of through traffic is clearly an important objective for people in this neighborhood. While downgrading Storrow Drive in whichever form it reduces traffic along the Esplanade is likely to find substantial support among the residents of Beacon Hill, some of its side effects might stir some opposition. Additional traffic on Charles Street north of Beacon Street as a consequence of removing the Arlington Street off-ramp is counter to the community's objective of reducing through traffic on local streets. As an alternative, as mentioned in Chapter 3.3, the Arlington Street off-ramp could be retained at a cost to the park improvement which would be otherwise achieved. The traffic assignment model predicts an increase of about 7,000 vehicles per day on Charles Street for the MED SCHEME, but a reduction of almost 35,000 vehicles on Storrow Drive in each direction at Revere Street. Thus, because of the difference in size of the volume change, some might accept the trade-off.

Upgrade Turnpike. Some members of the BHCA claim that the Turnpike is underutilized and that some traffic could be diverted to that highway. On this issue, the neighborhood association sides with the *Boston Transportation Department*'s (BTD) proposals that the Massachusetts Turnpike Authority (MTA) construct ramps at Arlington and Berkeley Streets, as was examined in detail in Chapter 5.1.[177] Visions of shifting some of the Storrow Drive traffic has been more than rhetoric by Beacon Hill representatives in the *Bridge Design Review Committee* (BDRC) process. In fact, with many favoring the idea of relieving traffic on Charles River arterials, the committee recommended that additional studies be prepared which would look at the role of Storrow and Memorial Drive in relation to the Massachusetts Turnpike.[178]

Minimize Disruption. Disruption during construction, although limited, will add to the burden already imposed through the massive inconveniences expected with construction commencing on the CA/T project. Most of the options explored in Chapter 3 can be implemented in increments and primarily use existing facilities rather than contructing new ones. The reconstruction of Charles Circle, on the other hand, for either constructing an underpass or connecting the Red and Blue Lines, will create some non-marginal disruptions. Beacon Hill, however, has traditionally been a neighborhood where residents took a longer-term view. While there was some opposition to original plans by the *Massachusetts Bay Transportation Authority* (MBTA)[179] to extend the Blue Line to Charles Circle, the inconveniences associated with a Storrow underpass might appear to be more than offset by the final improved design.

Overall, Beacon Hill will reap many of the benefits of a downgraded Storrow Drive while paying only parts of its (transportation) costs. For this reason it could be expected that a scheme which was worked out in close cooperation with members of the community could find the necessary support in this neighborhood to be refined and implemented in the future.

6.2.2. Back Bay

Although also primarily residential in character, the Back Bay, unlike Beacon Hill, is expected to experience significant levels of growth over the next decade. The need to develop an adequate transportation plan in response to this expected development, prompted the *Boston Transportation Department* (BTD) to prepare a study on transportation strategies for the Back Bay.[180] In association with *Back Bay business and neighborhood associations*, the 1991 report developed a transportation plan in which several objectives were formulated, some of which have particular bearing on this discussion:

1. Reduce Drive Alone Commuting.
2. Expand and Strengthen the Use of Public Transportation.
3. Improve Traffic Circulation to Reduce Intrusion in Residential Areas and to Improve Access to the Commercial Area.
4. Enhance Pedestrian Circulation and Safety.

Reduce Drive-Alone Commuting. While the formulation of this objective represents the City's view, its effect on Back Bay traffic is one embraced by community leaders in the Back Bay. To reduce the number of single-occupant vehicles passing through the Back Bay, the report proposes to increase transit use and vehicle occupancy rates through programs such as CARAVAN and the formation of Transportation Management Associations (TMAs). TMAs are designed to discourage employees from driving alone through the subsidization of MBTA passes, van- and carpools. As a result, the policy should help achieve a reduction in drive alone commuting from currently 34% to 20% of all commuting trips.[181] These strategies reflect the need to absorb future growth in transportation demand by modes other than the private automobile, an important conclusion of Chapter 5.

Expand and Strengthen the Use of Public Transportation. As a complementary measure to reducing automobile commuting, the report proposes several ways by which the use of public transportation could be achieved. According to the transportation plan, such measures could include creating a regional park-and-ride task force, increasing the number of fringe parking lots, expanding transit services to areas where they are currently insufficient to absorb growth in development, constructing high occupancy vehicle (HOV) lanes on the Southeast Expressway, and performing various operations improvements throughout the transit system.[182] The construction of a circumferential transit system, as discussed in Chapter 5.3, although not mentioned explicitly in this context, would help to achieve the formulated objective by diverting some automobile trips to transit.

Improve Traffic Circulation. Traffic circulation improvements are based on the concept that traffic be focused on key corridors. The City wants Storrow Drive and the Massachusetts Turnpike to provide regional connections to the commercial area of the Back Bay and be complemented by arterials as depicted in **Figure 6.2-1.** While some neighborhood residents might not agree that traffic should be concentrated on Storrow Drive, there seems to be agreement that it is still favoured over an increases in traffic on local streets. Most strategies proposed involve traffic management techniques such as improved signalization, parking enforcement and geometric configuration changes. Three of the formulated strategies are of direct interest to the options examined in this paper:

1. Upgrade Massachusetts Avenue: One is the proposal to upgrade Massachusetts Avenue — through techniques such as a ramp addition at Storrow Drive and left-turn restrictions — to absorb more commuter traffic and divert it from other local streets in the Back Bay. Alternatively, as has been shown in the traffic analysis of Chapter 4, a reduction in North-South cross traffic in the Back Bay, especially along Arlington, Berkeley and Clarendon Streets, could be achieved by downgrading Storrow Drive. Therefore, the objectives by the plan could be achieved even without an upgrade of

Massachusetts Avenue which, because the improved flow on Massachusetts Avenue would lead to a prohibition of most left turns, could actually reduce accessibility of the Back Bay from the West, an objective formulated by the City below.

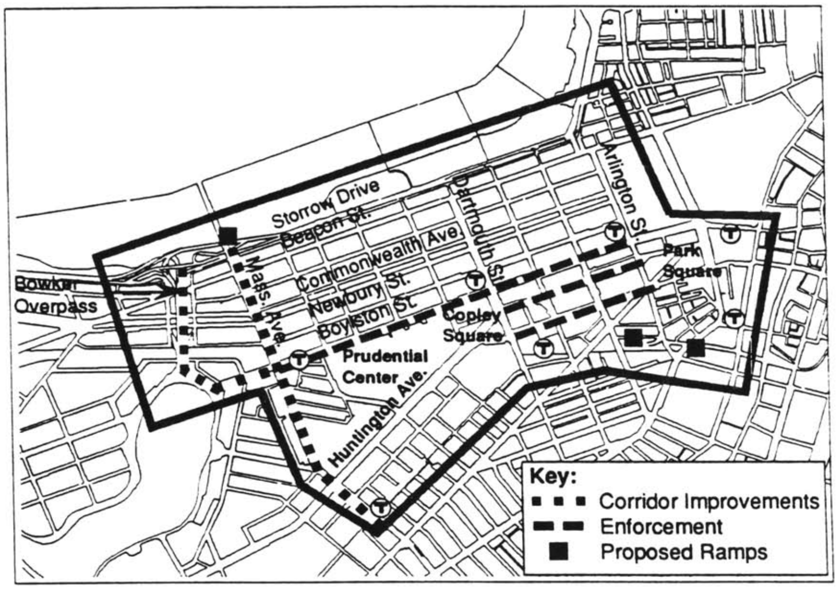


Figure 6.2-1. Primary Focus of Traffic Circulation Improvements from BTD Report.

2. Improve Access From West: Another strategy put forward by the BTD is to improve the connection between Storrow Drive and the Back Bay via the Bowker Overpass. This would effectively reduce traffic currently accessing the Back Bay from the East via the Clarendon and Arlington Street exits. Encouraging access and egress at the western end of the Back Bay, as envisioned by this plan, would therefore facilitate a reduced role of Storrow Drive East of Charlesgate for regional access to the Back Bay from the West. In **Figure 3.4-1** the connecting from Storrow Drive to Boylston Street westbound was not explicitly included. The environmental upgrade of Storrow Drive, rather than attracting cars form the West would discourage access from the East, therby achieving the same objective without creating an additional incentive for people to choose their cars as the mode of access to the Back Bay.

3. Construct Turnpike Ramps: A third strategy is the construction of the Arlington and Berkeley ramps for the Massachusetts Turnpike. As examined in detail in Chapter

5.1, if feasible to construct, this would increase the Turnpike's potential to provide a better connection to Back Bay locations and to serve as a more complementary facility to Storrow Drive. Due to the heavy concentration of commercial acitivity and location of parking garages (**Figure 6.2-2**) in the Prudential/Copley district, large numbers of vehicles cross local streets and arterials through the Back Bay residential district. The existing locations of most major arterial and highway access points generate a lot of through trips in these residential areas by vehicles who have neither trip end in them. As was discussed in Chapter 5.1, creating access points in the vicinity of the commercial area is functionally useful in that it reduces cross traffic through residential districts but would stir some opposition by Chinatown and Back Bay residents who would be exposed to increased levels of traffic and the disruption associated with construction of such ramps.

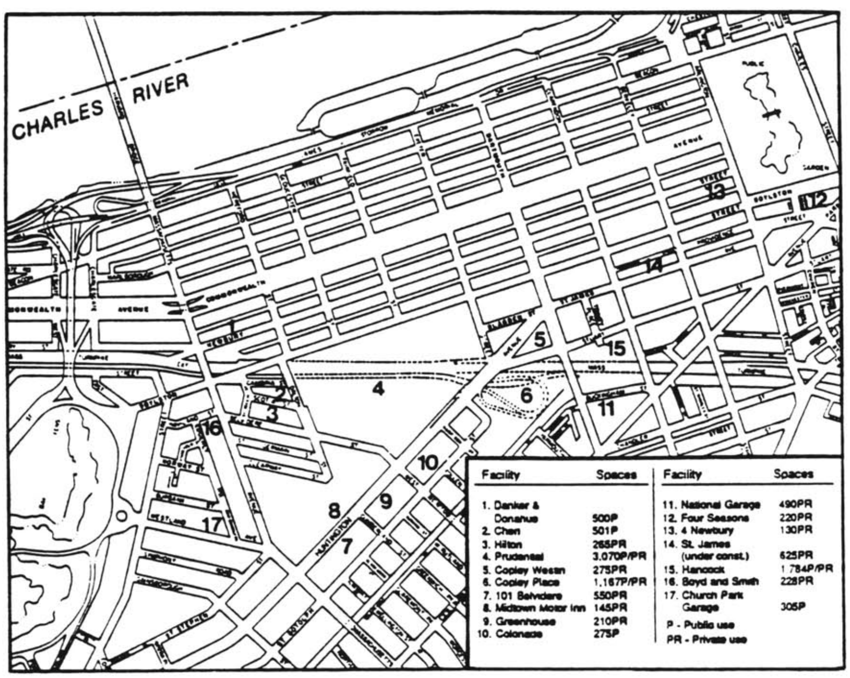


Figure 6.2-2. Location of Large Off-Street Parking Facilities in the Back Bay.

Enhance Pedestrian Circulation and Safety. According to the report, pedestrian and vehicular needs along specific corridors should be balanced. Arlington, Dartmouth, Newbury and Boylston Streets are areas with high pedestrian activity which warrant pedestrian improvements. The discussion focuses primarily on how to improve pedestrian capacity through the better placement of street furniture, adaptation of design standards, different curb cuts and pedestrian actuated signals.[183] The intersections of Arlington/Beacon Street/Embankment Road as well as Arlington Street/Commonwealth Avenue would be substantially improved under the downgrading schemes which remove the Arlington Street off-ramp from Storrow Drive as discussed in Chapter 3.3. Thus, it seems likely that the improvements to pedestrian circulation, which are stimulated by the amenities associated with a scaled-down Storrow Drive, would be welcomed by people in the Back Bay as well as the city.

Open Space Enhancements. In addition to the positions on transportation questions expressed in the Transportation Plan for the Back Bay, which might actually reflect more upon the City's and business interests, the *Neighborhood Association of the Back Bay (NABB)* and *Fenway Civic Association (FCA)* have cited great interest in open spcae improvements as envisioned in the RiverVision/2020 proposal. In response to presentations at these associations, they expressed interest in "increased access to the riverfront, expansion of recreational acreage and the downgrading of Storrow Drive,"[184] claiming the development vision made "beautiful sense."[185]

6.2.3. City and State Agencies

While the City and, to a limited extent, the State have been involved in formulating transportation plans in the affected neighborhoods, this section will briefly summarize positions taken by key agencies regarding the role of transportation and Storrow Drive beyond those elaborated upon above.

Boston Transportation Department.[186] The BTD is the key agency to sign off plans involving changes to the city's transportation environment. Their commitment to improving urban transportation in the city is focussed on improving traffic flows and air quality while increasing public safety. Through the planning of public transit expansions, such as the the organization of transportation management associations and ridesharing programs they are committed to divert future traffic growth to non-automobile modes. Similarly, a report published by the Mayor on Boston's future economic development directions, focuses on traffic circulation improvements and infrastrucutre expansions, such as the "Bioscience Line," the South Boston Piers Transit Way and Old Colony Rail Line.[187] As regards the role of Storrow Drive, the BTD has no special interest in downgrading the expressway because of expected problems with traffic diversion. While a channeling of traffic onto this corridor is one of the objectives pursued, the BTD does not want traffic on Storrow Drive to increase.[188] Rather, measures have focussed on the improvement of traffic flush-out at Leverett Circle, the maintenance of constraints in the roadway geometry, and elimination of hazardous ramps, as has been done at Dartmouth Street and Charles Circle[189] where two westbound off-ramps were closed during the last years. In general, the BTD's policies concerning Storrow Drive appear to be aimed at preservation rather than redesign.

Metropolitan District Commission (MDC).[190] The MDC was founded in 1919 as a merger of the Metropolitan Parks and Metropolitan Water and Sewer Commissions to help manage park and water areas which cross jurisdictional boundaries, such as the Charles River Basin and arterial parkways. The commission owns the land on which the parkways, Storrow Drive, the Bowker overpass and Charles Circle are located. The MDC's added responsibilities in the area of traffic enforcement and parking have been blamed by many for having allowed the intrusion into the Olmsted park system through the construction of the expressway and highway interchanges.[191] The MDC is one of the agencies which will determine what will happen with the future layout of Storrow Drive. While the MDC has done little to promote ideas on possible redesign options for Storrow Drive, primarily for a lack of funds, there is some concern about the roadway's divide impact and the amount of space consumed by automobile transportation in the original park. Nevertheless, the MDC's primary commitment seems to be one of improving the aesthetics of the roadway design rather than rethinking the role of Storrow Drive in years to come.

Boston Redevelopment Authority (BRA).[192] The BRA is the principal planning agency in Boston responsible for overall land-use and economic development. While planning is built on a process of simultaneous agreement with land-use and transportation goals, the motivation and implementation of development options are primarily driven by economic and urban design, not transportation criteria which are the primary responsibility of the BTD. In accordace with objectives formulated by the transportation department, the BRA prefers Storrow Drive traffic to traffic on local streets in the city. The addition of Turnpike ramps and improvement of regional accessibility of the Back Bay from the South is also seen as an important next step. However, there are concerns about mainline queuing, toll collection[193] and possible opposition from Bay Village residents. Because city streets are already close to or at capacity, and because of the limited opportunities to increase road capacity in the future, the agency sees a need to reduce metropolitan-wide vehicle-miles travelled in general. The Storrow Drive downgrade vision is therefore seen as a logical consequence of that view.

Analysis so far has focussed on positions taken by residents and planning agencies in Boston. To balance these views, the objectives of the state, as formulated by a member of the planning staff, will briefly be discussed.[194]

Massachusetts Executive Office of Transportation and Construction (EOTC). The Central Transportation Planning Staff (CTPS) is the planning arm of the EOTC. By performing analysis on a regional level, policy considerations regarding transportation planning might be more state-wide in scale than those by the City. This means that CTPS, to some extent, represents the interests of those who use Storrow Drive as a regional highway link but do not live in the city. Storrow Drive's crucial role in the transportation system is considered a critical argument against its downgrading. Unless Storrow Drive could be depressed, there is believed to be little chance that traffic diverted from a downgraded Storrow will not spill onto neighborhood streets. Memoranda in the past years have shown the effect on local traffic volumes of both, a severing of the Leverett connection between I-93 and Storrow Drive[195] and various actions to change the relationship of Storrow Drive and the Massachusetts Tunrpike.[196] Generally, a larger role for the Tunrpike is envisioned in the future and upgrading measures, as were examined in Chapter 5.1, have been examined by CTPS as possible actions. Possible increases of total vehicle-hours and -miles travelled, in absence of an effective parking and transit policy, would stir opposition among the state planning agency as would possible increases in congestion at selected locations.[197] As is the case with the BTD, some elements of the plan, such as a mainline depression of Storrow Drive under Charles Circle, as well as some of the policies examined would be supported, but there again seems to be a tendency towards making the best of the current system without radically transforming it.

In sum, the idea of improving access between the Esplanade and abutting neighborhoods is likely to be embraced by all the actors whose positions were discussed above. Similarly, the need to further improve or expand the existing public transportation system is an idea supported by a majority. The transportation effects of a downgrading scheme or capital investments required for some elements of it, however, will be differently evaluated by these parties. An open and sincere public discussion focussing on these concerns and further study of options could realistically move the vision closer — and the Charles River too.

6.3. Timing

Today, there is a unique opportunity to translate these plans into action. The expansion of open space, enhancement of pedestrian connections and improvement of the public transportation system are supported by the following developments:

First, this decade will see the construction and completion of the Central Artery/Third Harbor Tunnel project. The Central Artery project is not only designed to shift vehicles currently using detours to avoid the Central Artery bottleneck from local streets to the underground highway after its completion, but will drastically affect travel patterns during construction when disruptions in the road network will prompt many to use pulic transportation. There is a unique opportunity in Boston to capture substantial additional ridership on an *improved* public transportation system., which might choose *not* to revert to driving their cars again after completion of the CA/T project.

Second, the passage of the Intermodal Transportation Efficiency Act (ISTEA) in the fall of 1991 has created a completely changed funding environment for public transportation, pedestrian, bikeway and urban design improvements individually or in conjunction with roadway projects. This means that there is a new opportunity to augment the envisioned highway improvements with comparable improvements for the urban environment, such that, in the longer run, the dependence on the automobile in cities could be reduced.

Third, visions of a Boston Olympics in the first decade of the 21st century could be materialized by finding efficient ways to transport visitors by water, rail and foot. The impetus from this should be used for transportation improvements throughout Boston and the metropolitan area.

6.3.1. Impacts of the CA/T Project

Most travel decisions are not revised on a daily basis. Relatively fixed travel patterns are typically established after a short trial period when individuals or families move to a specific location. Unless changes in variables of the transportation system are substantial, individuals will not reconsider their route, mode, or time of day for travel.

The construction of the Central Artery/Third Harbor Tunnel *is* of a magnitude to significantly affect travel behavior. Although phasing of the project is designed so as to minimize disruption during construction, the sheer size of the undertaking is likely to create traffic delays throughout the road network. As a response to this, the City is already looking for transit to accomodate some additional demand. Once people change their travel behavior as a response to the automobile-adverse environment created through construction, there is an opportunity to make them committed transit riders. As could be witnessed with Bay Area Rapid Transit (BART) use in the San Franciso Bay Area after the 1989 earthquake shock, ridership has remained high even after reconstruction of the

Bay Bridge allowed vehicles to resume their previous travel habits.[198] A high level of ridership could be retained by improving the public transportation system, as envisioned in Chapter 5.3, while simultaneously reducing road capacity along those corridors which should find relief from traffic through the completion of the CA/T.

The failure to use this time to upgrade transit services and downgrade parts of the road system will lead to much greater increases in automobile travel once the Central Artery is in place. The assumption of no changes in the environment, other than those put forward by the MBTA in their capital investment program, is the driving force behind generating a year 2010 trip table which increases the number of daily trips in the subregion by 500,000 or 18%.

Once the depressed Artery and Third Harbor Tunnel are in place, an aggressive transportation management plan should be implemented which would effectively channel vehicles onto the expanded facilities while simultaneously discouraging the use of parallel or critically located roadways. These could then be converted to better serve pedestrians and bicyclists, improving mobility and accessibility for those who are non-motorized. In absence of such a transportation strategy, Boston will soon see both, increases in traffic on its new highway facilities and increases on neighborhood streets with vehicles using them as bypass or overflow facilities to the highways. With the implementation of a parking freeze and construction of circumferential transit, however, complemented by reductions in capacity, such increases in traffic on local streets could be avoided.

6.3.2. Impacts of ISTEA

Last year, the Intermodal Surface Transportation Efficiency Act (ISTEA), was passed by Congress. While several amendments to the Highway Interstate Act of 1956, such as the Federal Aid Highway Act of 1973,[199] provided some flexibility in terms of the allocation of federal funds for transit rather than highway purposes, ISTEA goes well beyond that. In the policy declaration section of the Act it is stated that

> "...the National Intermodal Transportation System shall include significant improvements in public transportation necessary to achieve national goals for improved air quality, energy conservation, international

> competitiveness, and mobility for elderly persons, persons with disabilities, and economically disadvantaged persons in urban and rural areas of the country. [...] Social benefits must be considered with particular attention to the external benefits of reduced air pollution, reduced traffic congestion and other aspects of the quality of life in the United States."[200]

A greater focus on problems specific to transportation planning in urban settings becomes evident through the inclusion of a set of new provisions as specified in the Act. In these, particular stress is laid on the linkage of transportation projects with land use, quality of the pedestrian environment, bicycling and open space.

- The greater delegation of authority to state and especially Metropolitan Planing Organizations (MPOs) in terms of *spending discretion* over allocating funds to highways, transit or other uses.
- The consideration of effects of transportation policy decisions on *land use and development* and their consistency with the provisions of the applicable short- and long-term land use and development plan.
- The commitment of at least 10% of project cost for open space, pedestrian, bicycling, design and other *enhancement activities* beyond those funds applied for mitigative measures.
- The explicit treatment of walking and bicycling as modes of transportation and their role in *integrated transportation* policy planning.
- The establishment of a new *office for intermodalism* reflecting the recognition that urban transportation plans must apply a broader systems approach for the formulation of policies.
- The consideration of overall social, economic, energy, and environmental effects of transportation decisions.[201]

With ISTEA, transportation planning and legislation enters into its fifth generation. The first generation corresponds to the time from the emergence of automobiles up to the beginning of the 1950s. Dramatic examples of the mindset of transportation planners during this era are epitomized in the notorious "Whitten Report" of 1930 and Master

Highway Plan of 1948. In these planning reports the rationale of rights-of-way selections was primarily a combination of following travel "desire lines" and minimizing costs.[202] Valuable open space and low income neighborhoods were to be the primary victims during this planning stage.

In the late 1950s and early 1960s, damage avoidance became a central theme in urban transportation planning after a period of complete neglect of urban values. Large sections of the Interstate Highway Program were completed during this period which marks the beginning of public controversy surrounding the impact of highways on environmental values.[203]

The third generation is the "people versus highway" era where both the Inner Belt and Southwest Expressway projects in Boston, the Embarcadero Freeway in San Francisco and other highways throughout the country were stopped.[204] The opposition to highways was primarily based on the view that there needed to be a balance between mobility and other urban values, such as open space and pedestrian-friendly environments. It also was socially motivated in that lower-income people had been the primary victims of highway construction during the past decades.

The Clean Air Act of 1973 and amendments thereafter shifted the emphasis from the social and urban-environmental realm to the eco-environmental realm. Achievement of specified air quality standards became a primary objective and, linked with the oil crises of 1973 and 1979, led to an exploration of the potential for alternative, less-polluting fuels in urban automotive transportation. Transportation policy decisions in areas which are a far cry from achieving federal air quality standards, such as Los Angeles, are still primarily motivated by compliance requirements.[205]

The advocacy position taken by ISTEA is a completely new development in transportation legislation. It could support financing pedestrian and environmental improvements which stand on their own merit, such as the enhancement of park characteristics and pedestrian accessibility of Storrow Drive, as long as a nexus to transportation is maintained. Chapter 6.1 focused on the discussion of some of these linkages with transit improvements such as the Red Line-Blue Line Connector and Circumferential Transit. ISTEA, in utilizing the project relationships, could therefore become a crucial force behind providing the means for improving transit services while enhancing open space and the pedestrian environment.

6.3.3. Boston Olympics 2004

Boston is competing with several other cities for hosting the 2004 Olympics. In an October 1992 article of the Boston Globe, US Senator Kerry is quoted claiming that "Boston ...fits the profile of the Olympics to a T."[206] The Senator, Governor Weld and Mayor Flynn have all expressed excitement about the proposal which they support hoping for a boost to the regional economy from the Games. Noy only have cities hosting Olympic Games in the past earned substantial dollar amounts to pump into their economies[207], but the impetus and economic activity generated by this often led to large-scale investments in transportation infrastructure which yielded benefits years after the Games were over. In Los Angeles, a comprehensive ridesharing program was initiated to manage transportation demand during the peak Olympic season. The city of Munich, Germany, translated the need for expanded public transportation into a functioning system of underground rapid transit which has been expanded ever since its opening for the Olympics in 1972.[208] These examples show how a one-time event of the significance of the Olympic Games can mobilize the community and promote the creation of lasting transportation solutions.

According to the preliminary plans of the Boston Olympic Organizing Committee, the majority of events could take place along the banks of the Charles River, from the Museum of Science to the Eliot Bridge (**Figure 6.3-1**).[209] This has several implications:

- It generates substantial impetus to improve pedestrian connections along the Charles River as well as between city locations and the river,
- It stimulates interest in improving urban design along the river edge as well as in the vicinity of Charlesgate, the Back Bay and Beacon Hill.
- It provides an additional rationale for proceeding with the construction of some kind of circumferential connection to link important activity centers along the river and throughout the city,[210]
- It creates the opportunity to construct a complementary transit extension to the West in

parallel to the existing Green Line, achievable through an extension of the Blue Line West or similar transit service,

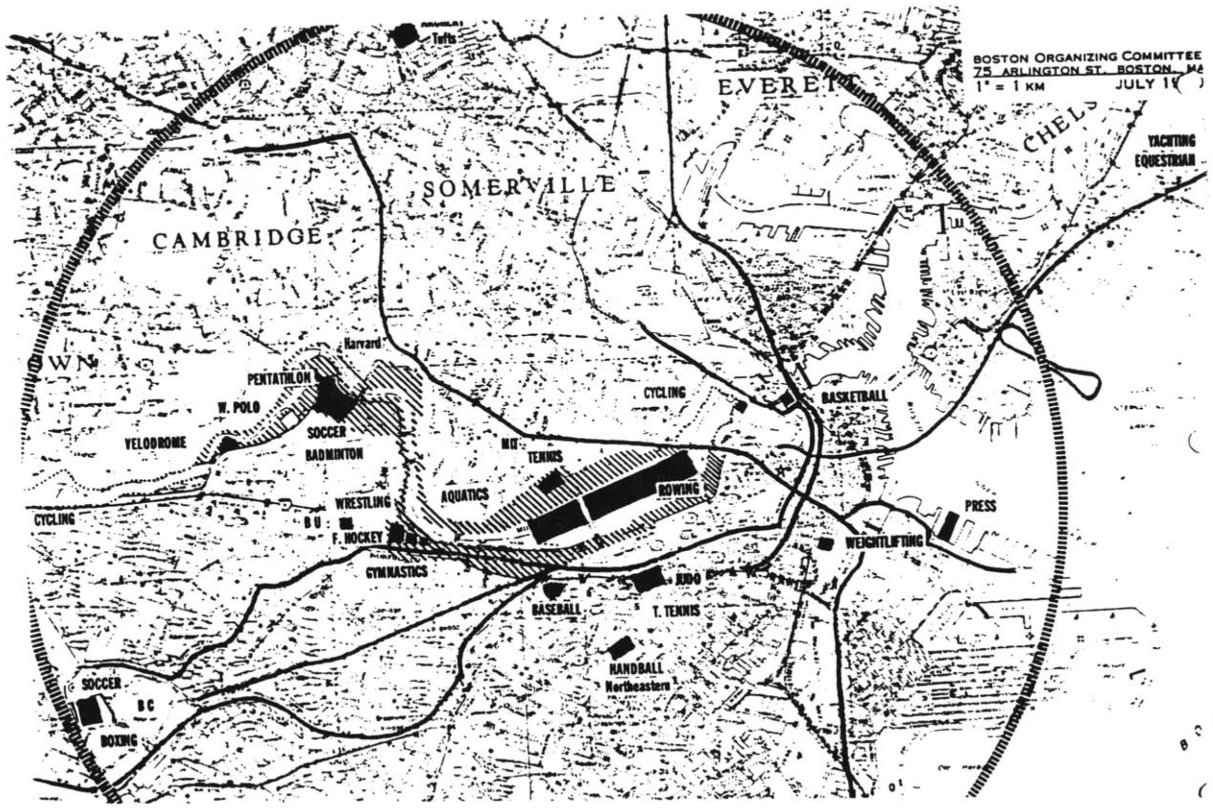


Figure 6.3-1. Site Plan of Sporting Events Centers for a Boston Olympics.

In sum, the Boston Olympics could become a vital stimulus for addressing the same kinds of questions of river accessibility which have been the motivating factors for this thesis. In this vein, should the dream of Olympia really come true for Boston within the next two decades, so could James J. Storrow's: the re-creation of an accessible river promenade.

CONCLUSION

Highway construction and expansion in the postwar years have created dramatic and damaging incisions into the urban park system. The comsumption of valuable land by massive interchanges and curtailment of pedestrian mobility in and around these areas have had severe impacts along the Charles River Esplanade and its linkage points with the rest of the park system and neighborhoods.

Traditionally, transportation policies have been directed towards insuring that vehicular mobility to and around the city be maintained while attempting to at least minimize the negative impacts on open space and the pedestrian environment. The result has often been brief periods of relief for motorists after an increase in capacity at an accumulating cost to the non-driving public. Traffic projections for the year 2010 indicate that this approach will not lead to a long-lasting solution of the urban mobility problem.

The capacity expansion of the Central Artery could have the same effect. However, if the opportunity to act during the implementation of the CA/T project is realized and already committed to agreements on a limitation of automobile growth are honored, transportation policy could shift from a of controlling damage to a proactive force in enhancing the urban environment. It is a timely event to start thinking about transportation as being one element of an urban and environmental system rather than of parks and people as one element in a transportation plan.

The 1991 Intermodal Surface Transportation Efficency Act provides an important complementary stimulus to initiate a planning direction which would be guided by the environmental objectives. The benefits afforded by a policy approach which recognizes and reinforces those elements of the urban environment which are valued by the community are real and long-lasting. This is the direction urban transportation planning was proposed to follow.

The re-connection of the Esplanade with the neighborhoods which are located next to it would expand the pedestrian realm of parts of downtown Boston and improve the quality for residents and visitors alike. Thus, the downgrading of Storrow Drive could serve as a prototype for the improvement of the urban living space, a concept which could be carried much further to other arterials in Boston and Cambridge. In addition to improving access along its sides, the redesign of Storrow Drive could illustrate vividly what the benefits of a parking freeze or transit expansion really are and thereby strengthen the appeal of such policies to those who would otherwise rely on their automobiles.

The immanent completion of the BTPR mandate will open a debate on the "what is next in transportation planning?" Boston has all the assets to take the necessary steps forward, an Olmsted-designed park system, a vital pedestrian core, an expansive and functioning transit system, a diverse and technologically advanced economy, and highly regarded medical and educational institutions. It has all the natural and urban resources, know-how and history which make it distinct. If Boston can't move forward, who can?

Notes

1. Karl T. Haglund, "Boston's Court of Honor: The Almost Foregone Creation of the Charles River Basin" in *Landscape and Architecture*, Margaret McAvin, ed. (Providence, RI, 1988), p. 125.

2. *Metropolitan Area Parks*, p. 150.

3. *Boston Parks*, p. 31.

4. *Boston Parks*, p. 151.

5. Bainbridge Bunting, *Houses of Boston's Back Bay: An Architectural History, 1840-1917* (Cambridge, MA, 1967), pp. 363-364.

6. see Karl Haglund "Boston's Court of Honor," p.127

7. Max Hall, in his book *The Charles - The People's River*, quotes the period between 1859 and 1880 for the filling of the Back Bay, p. 34.

8. *Boston Parks*, p. 31.

9. Zaitzevsky, p.13.

10. F.L. Olmsted (catalogued author), *Olmsted's Park System as a Vehicle in Boston*, 1973, p.3, Boston Parks, p.21.

11. "To be behind in [expending money on the improvements of parks, squares, gardens and promenades] would not only be discreditable to our city, but positively injurious to our commercial prosperity, and in direct opposition to the wishes of the vast majority of the citizens" (Special Park Committee appointed in 1859, quoted in Zaitzevsky, p.35).

12. Frederick Law Olmsted, who was to become one of the most influential protagonists in the park movement, criticized the forces which were responsible for "excluding nature from the urban experience," artificially creating a dependence of city upon country. ibid., p.3-4.

13. Karl Haglund, p.127. In 1890, Charles Eliot is quoted for urging nature lovers to "rally to preserve for themselves and all the people" the beauty that still existed near their doors, (quoted in Max Hall, p.43).

14. However, some believed that improved means of transportation would help to inexpensively reach more remote sites for recreation (Zaitzevsky, p.36) With land acquisition costs in the core much higher than in the outskirts, this proposition was attractive especially form an economic point of view.

15. Specifically, George B. Emerson declared that parks would add significantly to the "happiness of the common people," Boston Parks, p.22. Frederick Law Olmsted's criterion for park site selection were based on "accessibility for all classes of citizens," Cynthia Zaitzevsky, *Frederick Law Olmsted and the Boston Park System*, 1982, p.44.

16. Zaitzevsky, p.3.

17. Karl Haglund, p.127.

18. *Boston Parks*, pp. 150-156.

19. *Boston Parks*, p. ?.

20. Charles Eliot, "The Boston Metropolitan Reservation," *New England Magazine* 15:1 (September 1896), pp. 117-118; Haglund, pp. 126-127.

21. Zaitzevsky, figures; Haglund, *Boston's Court of Honor*, p. 127.

22. Haglund, *The Charles River Basin*, Chapter 5: Developing the Basin, pp.1-2; Boston Transit Commission, 14th Annual Report, June 30, 1908, pp. 8-9, 16th Annual Report, June 30, 1910, pp. 8-9 and 17th Annual Report, June 30, 1911, pp. 30-38; Zaitzevsky, p.96.

23. Max Hall, *The Charles - The People's River*, p. 44.

24. Haglund, *The Charles River Basin*, p. 40.

25. Max Hall, pp. 50-52.

26. *Boston Parks*, p. 152.

27. Haglund, *Boston's Court of Honor*, Ch. 5, p. 7; *Metropolitan Parks*, p. 156.

28. Commonwealth of Massachusetts, Special Commission on the Charles River Basin, *Report on the Proposed Improvements of the Charles River Basin*, p.10; *Boston Herald*, March 21, 1929, p.1,4; *Boston Evening Transcript*, January 23, 1929, part 2, p.14; *New York Times*, January 29, 1929, p.6E; Haglund, *The CRB*, Ch. 5, p.42; Max Hall, p.60.

29. Haglund, *The CRB*, p.43.

30. Haglund, *The CRB*, p.44; Arthur Shurcliff wrote in 1923 that in "this epoch of the revolution of vehicular transportation" there was a powerful temptation to overdevelop the parkways "as a matter of immediate relief and instant economy" (*Boston Evening Transcript*, September 29, 1923, quoted in Haglund, *The CRB*, Ch. 5, p.44); Zaitzevsky, p. 208.

31. "The plan as proposed by the Special Commission -- not approved by the legislature -- provided for the construction of a sunken roadway through a portion of the park strip ...created

[by the widening of the existing shore park through landfill]. The Act authorizing the improvement of the basin while authorizing the construction of the park strip, provides that no portion of it shall be used for roadway purposes without further authorization by the legislature" (quoted in the "Whitten Report," p.102; *Boston Herald*, March 21, 1929, 1, 4.

32. Haglund, *The CRB*, Chapter 6, p.1.

33. Robert Whitten, *Report on a Thoroughfare Plan for Boston*, (Boston, 1930), p.15.

34. "Whitten Report" p.5.

35. "The automobile has done wonders in taking population into undeveloped areas remote from transit lines" ("Whitten Report," p. 23). This statement reflects the beginning of the suburban movement which accelerated rapidly in the postwar years (see Chapter 5.5).

36. "Whitten Report," p.23.

37. Charles Maguire and Associates, *Master Highway Plan for Greater Boston*, 1948, p.62. Nevertheless, even Robert Whitten stated in his 1930 report that "the number of trips on city streets just for pleasure driving is negligible. Automobiles are used to get somewhere" (ibid., p.19).

38. Metropolitan Area Parks, p. 37.

39. *Boston Parks*, p. ?.

40. Commonwealth of Massachusetts, Metropolitan District Commission, *Study of the Traffic Situation in Boston* (Boston, 1946); Haglund, The CRB, Chapter 6, p.2.

41. Haglund, The CRB, Chapter 6, p.4.

42. Haglund, p.13_; Max Hall, p.60.

43. Central Transportation Planning Staff, *The Demographics of Commuting in Greater Boston* (October 26, 1989), pp. 3-15.

44. According to Yong Chang at CTPS, these include:
   1. Completed Old Colony Rail Line
   2. Green Line extension to Arborway
   3. Replacement service along the corridor of the old Orange Line
   4. Newport Extension
   5. Shortened Commuter Rail travel times (to 0.5 hours)
   6. Local bus service improvements
   7. 7 express bus lines.

45. The "hook" at this location seems to show that most traffic going northward on Columbus turns right onto Mealnea Cass Boulevard and traffic going southward turns left from Melnea Cass Boulevard onto Columbus Avenue. A discussion with one of CTPS' traffic modelers, Tom Lisco, revealed that there is a problem with the network coding in this location which results in this strange assignment. It does not correspond to the traffic movements which are actually occuring in this location. However, this information was relayed to me too late to rerun all assignments with artificial delay links to remove the assignment or coding error. Therefore, all assignments will appear with this idiosyncratic hook. Since all scenarios have this feature in common, it won't affect the validity of volume *comparisons* in this study.

46. The emergence of "new" green lines in the plot indicating volumes greater than 10,000 vehicles per direction does not in itself imply a dramatic increase in volumes from the year 1987. A lot of "broken" lines have become solid as a consequence of them being pushed over the 10,000 mark from volumes probably very close to 10,000 in 1987. Massachusetts Avenue and Cambridge Street in Cambridge and Columbia Road in Boston are two examples of arterials which had volumes over 10,000 vehicles only in some locations in 1987 but would have so almost over their entire length in 2010.

47. Two significant differences between the CTPS and my own assignments should be noted. One is a differential of about 5,000 vehicles on the Massachusetts Turnpike east of Beacon Park, another a smilar differential on Tobin Bridge southbound. This volume difference is a direct consequence of differently coded tolls. A CTPS Memorandum by Eduardo Pereira, "Estimation of the Impact of Toll Changes on Sumner Tunnel and Tobin Bridge Weekday Traffic Volumes," from April 28, 1989, indicates that in order to model changes in toll charges, as this paper does in Chapter 6.1, a rule-of-thumb technique called the "quarter rule" should be applied. Traffic assignments by CTPS had concluded that representing the total cost of the toll increase as a commensurate increase in the toll link impedance would overstate the its impact. Therefore, toll changes should be coded as having only one-quarter of the "impedance cost" as would be calculated from a straight dollars-to-travel time conversion. However, at CTPS the "quarter rule" is only applied for *toll changes* rather than in the original network.

In my model, tolls are *originally* coded with only a quarter the actual impedance cost, unlike the CTPS model, because of this correspondence with CTPS. As was the case with the link coding error in the original CTPS network at Melnea Cass Boulevard which resulted in an overassignment of traffic yielding the "hook" described in footnote 45, this finding has been quite recent and was therefore not corrected in the network.

While the toll coding resulted from a misunderstanding on the application of the "quarter rule" it will yield correct estimates of the impact of a toll elimination. Under this coding rule, the calculated difference between the original toll link and the tested no-toll link has the correct (negative) cost of one-quarter the actual (negative cost).

48. See next endnote for explanation of accuracy of assignment estimates. In general, if the difference between traffic counts and assignment volumes, as shown in column 4 in **Table 1.2-2**, is larger than about one-third, I did not include it in this analysis.

49. However, it should be kept in mind that changes in link volumes as a consequence of a change in the network cannot be uniquely interpreted. While changes in the convenience of one travel route over another and consequent changes in link volumes will be simulated by the model, the calculated magnitude of this change might not reflect what would happen in reality. Therefore, the size of a volume change on links where the model estimate is significantly different from actual traffic counts is a less reliable number than the same for links where the it nearly approximates actual counts. As can be seen from this and in consecutive tables, local streets and arterials are typically and almost universally assigned lower volumes than they actually carry.

50. The sum of these districts corresponds to zones 1-60 in the model network. They are defined as Government Center, Financial District, North End, North Station, West End, Beacon Hill, Midtown-Retail, Chinatown-Bay Village, South Station/Leather District, Waterfront, Back Bay and Prudential Copley (Memorandum by Tom Lisco, "Potential Traffic Impacts of Eliminating from the CA/T Design Direct Ramp Connections Between Leverett Circle and the Central Artery, Tobin Bridge, and I-93 North," October 24, 1990).

51. Haglund, *The Charles River Basin*, Chronology.

52. Howard Needles Tammen & Bergendorff / Thomas Dyer, Inc., *Charles / Bowdoin Connector Project: Preliminary Design and Environmental Studies Status Report, Volume III*, (November 1987), pp. AH-14,15.

53. ibid., p. AH-15.

54. In its western portion, the expressway is called Soldiers Field Road.

55. Leverett Circle also provides all connections but its access to downtown Boston is not via a roadway of the magnitude of Cambridge Street.

56. A "typical" turning movement is here described as those turning movements most commonly performed such as Storrow EB - Cambridge Street, Storrow WB -Cambridge Street and Cambridge Street - Storrow EB. See **Table 1.2-6** for exact turning volumes.

57. Howard Needles, *Bowdoin / Charles Connector Project*, Exhibition 8, p. UD-8.

58. Alan M. Voorhees and Associates, Inc., *James J. Storrow Memorial Drive: Traffic Operations and Safety Improvement Program* (1973).

59. Howard Needles, Exhibit 7, p. UD-7.

60. Zaitzevsky, p.99.

61. Howard Needles, p. UD-1.

62. Alan Vorhees, p. IV-14.

63. Alan M. Voorhees and Associates, Inc., *James J. Storrow Memorial Drive: Traffic Operations and Safety Improvement Program*, (1973), p. IV-14; Cambridge Street Study Committee (CSSC), "Results of the Cambridge Street Survey," *memorandum*, (October 31, 1991), p. 2-5; Howard Needles, Exhibits 5-7 and p. UD-5,7.

64. Howard Needles, p. UD-7.

65. Cambridge Street Survey, p.2-5; Howard Needles, p. UD-5.

66. Cambridge Street Survey, pp. 2-5.

67. Howard Needles, p. AH-15.

68. Herbert Gans, quoted in Howard Needles, p. AH-15.

69. Howard Needles, pp. UD-3, UD-5.

70. Haglund, *The Charles River Basin*, Figures.

71. Maguire Associates, *Master Highway Plan for Greater Boston*, 1948, p. 76.

72. Alan Voorhees, p. 22; *Back Bay Redevelopment Plan* (1967), p. 37.

73. Back Bay Redevelopment Plan (1967), p.37.

74. Alan Voorhees, p. IV-20.

75. BB Dev't Plan (1967), p. 18.

76. Zaitzevsky, p.14.

77. see Kevin Lynch, *The Image of the City* and *Good City Form.*

78. Kevin Lynch, *The Image of the City*, (Cambridge, MA 1960), p. 172.

79. Haglund, *The CRB*, p. 36; Max Hall, p. 44.

80. Zaitzevsky, p.57.

81. For those interested in the history of landscape design, it should be noted that Arthur Shurcliff also used the name Shurtleff.

82. Haglund, The Charles River Basin.., p. 43 and p. 51.

83. *Olmsted's Park System as a Vehicle in Boston*, p. 31.

84. Massachusetts Bay Transportation Authority, *Draft Circumferential Transit Feasibility Study*, May 1989.

85. See, for example, Fort Point Associates, *FEIR (EOEA #6646), 899-925 Commonwealth Avenue* (Boston University's Armory Building), June 1990; Vanasse Hangen Brustlin, Inc, Longwood Medical Area Service Corporation (MASCO), *Longwood Medical Area Transportation Study, Technical Memorandum 1: Summary of Existing Conditions*, November 1987; HMM Associates, Inc, *FPIR/FEIR (EOEA #7643), Olmsted Plaza, A Redevelopment of the Sears Property, 309 Park Drive, 201 Brookline Avenue*, January 1990.

86. See, for example, *Circumferential Transit Feasibility Study*, Carl Zellner Memorandum, City of Boston, *Building Boston's Economic Future* (Bioscience Line).

87. quote from Circumferential Report, E. Nilsson, MASCO, p.57.

88. *The Greening of Boston: An Action Agenda*, p. 117.

89. From "Public Parks and the Enlargement of Towns", 1870, quoted in *The Greening of Boston: An Action Agenda*, p.27.

90. *Olmsted's Park System as a Vehicle in Boston*, p. 31.

91. *The Greening of Boston: An Action Agenda*, p. 27.

92. see Kevin Lynch, *The Image of the City*, Chapter 1.

93. In addition, as can be witnessed in the case of the CA/T project, the likelihood of obtaining FHWA funds will increase if capacities are expanded. Therefore, future planners could come under pressure to widen Storrow Drive, especially during times when federal monies are desperately needed to create local jobs.

94. Many are concerned about the effect of a depression of Storrow Drive on the water table. There have been significant problems in the past which underline the difficulty of constructing underground in the landfill area of the Back Bay (Brimmer Street issue, construction of Hancock Tower). Furthermore, the disruption caused by such a project would equal that caused by the Central Artery if Storrow Drive maintains its current transportation function. Therefore, this option has not been further examined in this paper.

95. Alan M. Voorhees and Associates, Inc., *James J. Storrow Memorial Drive Traffic Operations and Safety Improvement Program* (1973), p. IV-11.

96. From an interview with John Maservi, Director of Planning at the Massachusetts General Hospital, February 7, 1992.

97. Haglund, *The Charles River Basin*, Chronology; Zaitzevsky, p. ?.

98. There are two possible physical constraints. One is whether the section between the first two columns has the required 14-foot clearance. Initial observations gave me the impression that there is sufficient space. A second possible constraint are supportive beams under the Charles Street Station which would possible have to be replaced. A third is that with the narrower alignment of Cambridge Street leading out of Charles Circle to the East, probably only two lanes could be accommodated. However, observation of traffic passing through this narrow S-curve shows that because of the sharpness of the turns only two lanes are fully used today. If this design would prove to be non-workable, an alternative, rotary-improvement design is shown in the appendix.

99. See also Howard Needles, p. UD-10, for improvement suggestions.

100. Howard Needles, pp. UD-5, UD-10. In this report, relevant variables for pedestrian-oriented land use in the area are defined as follows:

1. direction and relative quantity of pedestrian movements
2. important pedestrian sightlines and views
3. relationship between pedestrian movements and origins/destinations
4. location of pedestrian/vehicular interfaces and potential conflicts
5. conditions perceived as confining or encroaching on pedestrian-oriented space
6. park areas, landscaped areas, street trees
7. brick pavement and pedestrian-scale street lights
8. dual role of medians
9. location and extent of deficient sidewalk widths
10. topographic changes within the area
11. pedestrian amenities
12. visual contribution of historically significant architecture

101. Howard Needles, p. UD-5.

102. Boston Transportation Department, *Beacon Hill Neighborhood Transportation Planning Study*, p. III-6.

103. Even very slow people could cross an entire road width in one signal phase (about 30-40 seconds) under this design.

104. Alan Voorhees, *Bowdoin / Charles Connector Project* (1987).

105. From a meeting between the Beacon Hill Civic Association and business owners along Cambridge Street, February 4, 1992; *Cambridge Street Survey*, October 1991.

106. Beacon Hill Civic Association, *Cambridge Street Survey*, 1991, pp. 2-5.

107. "The design of Charles Station can serve as a symbolic gateway to the City and as a visually dynamic focal point for Cambridge Street. Reinforcing the strength of this link is an exciting design challenge" (from Howard Needles, p. UD-1).

108. Howard Needles, p. UD-10.

109. See, for instance, Alan Voorhees, part IV.

110. For instance, the elevated structure not part of the station should be redesigned with the following objectives: a) minimize noise levels, b) minimize sunlight blocking from above (e.g. use porous horizontal structures), c) maximize cross views (i.e. limit vertical height of elevated structure above columns), d) beautify column structures themselves.

111. Boston Transportation Department, *Beacon Hill Neighborhood Transportation Planning Study*.

112. From Alan Voorhees report on Storrow Drive (see references).

113. Since right turns from Storrow Drive eastbound into Dartmouth Street would not be allowed, pedestrian movements would not be interrupted or endangered during their green phase. This concept, without the left-turn opportunity, could also be applied to a future Gloucester Street Mall three blocks to the West. Furthermore, traffic signals could be programmed such that pedestrians — and left-turning vehicles — would have up to one-third green time during off-peaks and less than that during peak hours where Storrow Drive could use maximum capacity. This possible preferential green time treatment of Storrow Drive during peaks would only have a minor impact on pedestrian mobility since pedestrian peak volumes occur during mid-day and on weekends.

114. Designed by Fred Koetter AIA and Chris Iwerks with T. Kelly Wilson. Boston, Massachusetts. Awarded Special Mention.

115. One theme for the Boston Visions competition was to improve designs of the cityscape along its various waterfronts. **Figures 3.3-A1** and **3.3-A2** illustrate examples of two architects' vision on how this connection could be achieved.

116. See, for instance, Kevin Lynch, *The Image of the City*, Chapter 3.

117. The depression of the Turnpike under the Muddy River is a design put forward by architect Edward Nilsson in RiverVision/2020. Under this option, Charlesgate connections would continue at the surface level to the Fenway and Park Drive above the depressed Turnpike and railroads. Although one of the most comprehensive solutions to highway-open space interferences in this area, there is at least one major difficulty apart from the financing question. A depression of the rail tracks over a total length of nearly two-thirds of a mile on each side of the Muddy River would be required to get the rail tracks to a depth of 30 feet below the surface level at the Muddy River. In light of the expected disruption to both vehicular and transit movements during construction it is not clear how this major modification could be achieved without substantially affecting travel along this corridor. Nevertheless, research should continue to test the feasibility of this scheme or one where only the Turnpike would be depressed but the rail line remain at surface level with a commuter rail station at Ipswich Street.

118. I have not addressed design options for Leverett Circle but assumed a configuration as envisioned under the still exising proposed design, Scheme Z.

119. Signals at Gloucester and Pinckney Streets could be optionally included in this scheme but are not required from a systems point of view, which is the issue of discussion in this chapter.

120. The traffic characteristics of both option 2 and 3, although they have different connections between Charlesgate East/West and Storrow Drive, are assumed to be approximately represented by this scheme.

121. No signals are for the segment of Storrow Drive East of Charlesgate and for all Westbound traffic.

122. Signals for eastbound Storrow Drive traffic are at Charlesgate where turning connections are made to surface roads.

123. In regard to my concerns about the accuracy of these capacity estimates, I consulted Bruce Campbell from Bruce Campbell and Associates, a transportation consulting firm in Boston. Mr. Campbell informed me that although my estimates are relatively high, or "optimistic" in terms of my project proposal, they appeared to be appropriate for the purposes of my analysis. This is to inform the reader that the estimates are "good enough" to approximate the potential characteristics of a roadway as envisioned in this paper.

124. Bridge Design Review Committee, *Report on the Charles River Crossing*, p. 47, pp. 126-129), City of Boston, *Back Bay Development Plan*, p. 23, and other sources.

125. The City itself has been pursuing options to improve access to the downtown areas.

126. Please refer to **Table 5-A1** in the appendix for the treatment of tolls in the network.

127. This corresponds to an option selected by Tom Lisco at CTPS in the Memorandum "Preliminary Analysis of Options for Improving Ramp Access to the Mass Turnpike Extension Combined with Options for Downgrading Storrow Drive," April 30, 1991.

128. See reference in BDRC Report, p.129.

129. The "congestion level" is here simply defined as the ratio of volume to practical capacity of 1.25 or more. Practical capcity is measured as ten times hourly capacity. This information was obtained through Tom Lisco at CTPS.

130. In order to perform this analysis, I used both my own assignment results and those from work done by the Central Transportation Planning Staff (CTPS). A CTPS memorandum in April 1991 explored the traffic impacts of a Turnpike upgrade in conjunction with a Storrow Drive downgrade. The study concluded that while traffic volumes would be cut in half on Storrow Drive with a drastic reduction of the speed limit, only one-third of this traffic would be diverted to the Mass Turnpike. While some of the assumptions were different than the ones applied in

this analysis, the scenarios are reasonably similar and will be used for a screenline volume comparison below.

Comparing volume shifts at the designated screenline location, Massachusetts Avenue, the CTPS analysis indicates that at the former location eastbound Turnpike volumes would increase by about 16,000 vehicles and westbound volumes by 21,000 compared to the base case. My analysis shows that these increases would be 21,000 and 26,000 vehicles, respectively. The Turnpike volume increases are matched by a 25,000 vehicle reduction on Storrow Drive eastbound east of Massachusetts Avenue and by a 23,500 reduction westbound in the CTPS analysis. This indicates that on average approximately three-quarters of the Storrow Drive downgrading effect is absorbed by the Turnpike upgrade at this screenline, about two-thirds in eastbound and a little more than five-sixth in westbound direction. In my analysis, the Storrow Drive reductions are 31,000 eastbound and 30,000 westbound vehicles, corresponding to a shifting rate of more than two-thirds in eastbound and a little less than five-sixth in westbound direction. Thus, while volumes and volume shifts differ between the two analyses, the amount of *relative shift*, or *absorption rate*, of the upgraded Turnpike from the downgraded Storrow Drive is essentially the same.

This indicates that conclusion #2 in the CTPS memo contradicts its own findings and these as well.

131. Please refer to note #166 for a list of sources. Also see reference section for City of Irvine, Alan Altshuler and Wilfried Owen.

132. BTD, *Transportation Strategies for the Back Bay*, p. 11.

133. Metropolitan Planning Organization, *Policy Statement Regarding the Proposed Amendment to the Logan Airport Parking Freeze*, November 1988, p. 8.

134. Since the enforcement area of the parking freeze at Logan Airport was too small, Park & Fly lots sprung up at the periphery of the freeze area.

135. BTD, *1987 Downtown Boston Parking Inventory Survey*, July 1988, p. ii.

136. Metropolitan Planning Commission, *Proposed Amendment to the State Implementation Plan: A South Boston Parking Freeze Area*, November 28, 1990; Metropolitan Planning Commission, *Proposed Amendment to the State Implementation Plan: An East Boston/Revere Parking Freeze*, December 31, 1990.

137. Boston Metropolitan Planning Commission, *Proposed Amendment to the State Implementation Plan: An East Boston/Revere Parking Freeze*, December 31, 1990, p. 12.

138. But even this representation would exclude the possibility that someone might choose not to take the trip at all, an option generally ignored in the today's travel forecasting models.

139. It should be noted that zone numbers differ from those of the standard regional 775-zone model for zone numbers between 158-284.

140. Boston Transportation Department, *1987 Downtown Boston Parking Inventory Survey*, July 1988, p. ii.

141. In comparison to parking costs, out-of-pocket costs for the operation of an automobile are quite low. The Central Transportation Planning Staff (CTPS) and Cambridge Systematics (CSI) use an operating cost of just under $0.17 per mile in their Central Artery traffic model. From Bechtel/Parsons Brinckerhoff and Central Transportation Planning Staff, *Central Artery/Third Harbor Tunnel: Detailed Travel Model Description*, February 1990. A 15-mile round-trip costs a motorist only about $2.50, while the typical daily rate for parking a vehicle in downtown Boston is about $9/day. This estimate is based on a 21-day working month and a monthly rate of $186.00 as taken from the *1987 Downtown Boston Parking Inventory Survey*, July 1988, p. ii. This illustrates the potential of an effective parking policy beyond the proposed parking freeze. In fact, a parking fee hike of one-half systemwide would have a comparable impact as a parking freeze in terms of reducing the number of automobiles using the road network on an average weekday. This based on the following calculation: A parking rate increase of 50% results in a 8% decrease in travel if the elasticity rate is assumed to be -0.16. This elasticity is a lower average of three estimates stemming from a publication by the Department of Transportation, *Patronage Impacts of Changes in Transit Fares and Services*, September 1980.

142. Boston Transportation Department, *Transportation Strategies for the Back Bay*, p. 15.

143. See note #152 below.

144. Massachusetts Bay Transportation Authority, *Draft Circumferential Transit Feasibility Study, May 1989*, p. 17.

145. *Draft Circumferential Transit Feasibility Study*, p. 17.

146. *Draft Circumferential Transit Feasibility Study*, p. 47.

147. Ibid., p. 19.

148. City of Boston, *Building Boston's Economic Future: An Agenda for Economic Development*, pp. 38-39.

149. From *Draft Circumferential Transit Feasibility Study*, p.104.

150. If the 56,000 vehicle trips estimation is correct, then this would imply an avarage trip length of about 7 miles with TAMS assumption on total VMT reduction of 385,200 miles per day.

151. Defined as the percentage of new transit riders which were formally either auto drivers, auto passengers or which are new riders.

152. US Department of Energy (DOE), *San Diego Trolley: The First Three Years* (November 1984); US Deprtment of Energy, *The First Four Years of Metrorail: Travel Changes* (September 1981); Bart Impact Program, *BART's First Five Years: Transportation and Travel Patterns*

(1978).

153. The report states that the majority of new users of the system would be former transit users. However, their numeric estimates for Alternative 3D do *not* reflect this statement.

154. In fact, even this is not true. A discussion with Professor David Bernstein about the method of calculation used by traffic modeling software to determine travel paths through a selected link, concluded that these cannot be *uniquely* determined. The assignment process works in a way such as to equalize travel time on a large number of possible paths between any origin and destination. To stipulate a "shortest" path in terms of travel time between any o-d pair is therefore not correct. However, a set of routes can be identified as shortest paths and the select link results generated by the software generally approximate what is actually a set.

155. Memorandum by Carl Zellner, Bruce Campbell and Associates, "Blue Line/Riverside Line Linkage," June 26, 1991.

156. Public meetings during the first two weeks of February 1992. The one I attended was on February 12, 1992, at Powery Hall, 105 Jersey Street, in the vicinity of Kenmore Square.

157. From information hand-outs from the Massachusetts Turnpike Authority (MTA) at the public meeting, February 12, 1992.

158. Comunitas is an architecture/planning/urban design firm located in Boston. Comunitas developed the urban design plans which were presented at the meeting by its President, Antonio DiMambro.

159. Ibid.

160. Ibid.

161. Edward Nilsson and Associates, *RiverVision 2020: A Charles River Basin Masterplan*, 1989.

162. The excerpt of this program which is referred to here, is taken from B/PB and CTPS, *Detailed Travel Model Documentation*, Module 3.2 Regional Transit Networks, pp. 3.2-1 to 3.2-18.

163. Edward Nilsson letter to City of Boston, 1990.

164. Personal communication with Fred Salvucci, MIT and Peter Thomson, BHCA.

165. For information on the Southwest corridor see, for instance: Boston Transportation Planning Review (BTPR), *Draft Environmental Impact Report Southwest Corridor: Summary and Evaluation*, 1972; Alan Lupo, *Rites of Way*, 1971; Stanley F. Moss, *Documentation of the Southwest Corridor Project*, Master's Thesis at UMass at Boston, 1989; US Department of Transportation, *Final Environmental Impact Statement: Orange Line Relocation and Arterial Street Construction (Southwest Corridor Street Project)*, Vol I,II, 1978.

166. In Singapore an Area Licensing Scheme within the approximate CBD area drastically increased the cost of accessing the inner city by auto during the morning hours. At the same time, parking rates in the core were structured so as to discourage lon-term, i.e. commuter parking, but maintain shopping activity through preferential rates for short parkers. In addition to these measures, fringe parking lots with shuttle services, an improved radial route and improved bus connections to the core were established. Similarly, cities such as Gothenburg, Munich, Hong Kong and Bologna have adopted policy packages which aimed at limiting auto use and improving public transportation, primarily in the densest, most congested areas surrounding the downtown. The following sources contain information on experiances in cities worldwide:

Singapore:

1. Organization for Economic Cooperation and Development (OECD), *Managing Transport*, Chapter 14. Paris 1979.
2. Organization for Economic Cooperation and Development (OECD), *Seminar on Urban Transport and the Environment*, Part II, pp. 223-238. Paris 1979.
3. Organization for Economic Cooperation and Development (OECD), *Cities and Transport*, Chapter 10. Paris 1988.
4. John L. Taylor and David G. Williams, *Urban Planning Practice in Developing Countries*, Chapter 11. 1982.

Hong Kong:

1. Organization for Economic Cooperation and Development (OECD), *Cities and Transport*, Chapter 3. Paris 1988.
2. Scurfield, R.G., *Road User Charges, Tolls and the Provision of Roads and Tunnels in Hong Kong*, paper presented at the Planning and Transport Research and Computation (PTRC) 14th Summer Annual Meeting. July 1986.
3. Peter K.W. Fong, *Issues of the Electronic Road Pricing System in Hong Kong*, University of Hong Kong, Working Paper #4. January 1985.
3. Peter K.W. Fong, *An Evaluative Analysis of the Hong Kong Electronic Road Pricing System*, University of Hong Kong, Working Paper #12. December 1985.
4. Newbery, D.M., Hughes, G.A., Paterson, W.D.O., Bennathan, E., Road Transport Taxation in Developing Countries, World Bank Discussion Paper #26. April 1988.

Osaka:

1. Organization for Economic Cooperation and Development (OECD), *Seminar on Urban Transport and the Environment*, Chapter 5. Paris 1979.
2. Organization for Economic Cooperation and Development (OECD), *Cities and Transport*, Chapter 8. Paris 1988.

167. By no means do I intend to imply that this discussion will fully recongize and reflect the range of concerns held by the interviewees nor the other members of the community. This synthesis might only partially reflect the interviewee's views and my interpretation of answers is inherently subjective.

168. Bridge Design Review Committee (BDRC), *Report on the Charles River Crossing*, October 1991, p. 42.

169. Louis Berger and Associates, Inc., *Central Artery/Leverett Circle Connection - Feasibility Study*, May 1981.

170. Peter Thomson interview notes, October 30, 1991.

171. Correspondence between Peter Thomson (BHCA) and BDRC Chairman Stanley Miller; correspondence between Anthony Pangaro and Stanley Miller.

172. Peter Thomson interview notes, October 30, 1991; Bridge Design Review Committee, *Report on the Charles River Crossing*, pp. 127-128.

173. Peter Thomson interview notes, October 30, 1991.

174. Reference from Bill Kuttner, CTPS.

175. This is based on notes from an interview with John Maservi, Principal Planner at the Massachusetts General Hospital, February 7, 1992.

176. Boston Transportation Department, *Beacon Hill: Neighborhood Transportation Planning Study* February 1985, Chapters II and III.

177. Boston Transportation Department, *Transportation Strategies for the Back Bay*, June 1991, pp. 19-23.

178. BDRC, *Report on the Charles River Crossing*, October 1991, p. 122.

179. From interview notes with Fred Salvucci, February 1992, and Peter Thomson, October 1991.

180. Boston Transportation Department, *Transportation Strategies for the Back Bay*, June 1991.

181. Boston Transportation Department, *Transportation Strategies for the Back Bay*, June 1991, pp. 3-13.

182. Ibid., pp. 13-18.

183. Ibid., pp. 32-36.

184. Letter from the NABB to Edward Nilsson, dated June 14, 1990. This letter is included in the appendix of *RiverVision 2010: A Charles River Master Plan*, 1989.

185. Letter from the FCA to Steven Coyle, then Director of the BRA, dated October 26, 1990. This letter is included in the appendix of *RiverVision 2010: A Charles River Master Plan*, 1989.

186. Notes from interview with Joseph Beggan, Deputy Commissioner of Planning at the Boston Transportation Department, November 22, 1991.

187. City of Boston, *Building Boston's Economic Future: An Agenda for Economic Development*, December 1991, pp. 38-40.

188. For some, these two objectives might appear contradictory. I assume that the BTD's position is that Storrow traffic should not increase through added regional trips, but a diversion from local streets is acceptable.

189. There used to be a second westbound off-ramp at Charles Circle which fit a previous design of Charles Circle. This ramp proved to complicate turning movements at the traffic Circle and was closed after the reversal of Charles Street.

190. Notes from interview with Karl Haglund and Julia O'Brien, MDC representatives, November 22, 1991.

191. Compare endnote 39. *Boston Parks*, p. ?.

192. Based on notes from interview with Dick Garver, Deputy Director of the Boston Redevelopment Authority, October 28, 1991.

193. These stem from preliminary work done by the Massachusetts Turnpike Authority (MTA) and CTPS.

194. This section is based on discussions with Tom Lisco, Manager of CA/T Traffic Forecasting at the Central Transportation Planning Staff, the EOTC's principal planning agency.

195. Memorandum by Tom Lisco, CTPS, "Potential Traffic Impacts of Eliminating from the CA/T Design Direct Ramp COnnections between Leverett Cricle and the Central Artery, Tobin Bridge, and I-93 North," October 24, 1990.

196. Memorandum by Tom Lisco, CTPS, "Preliminary Analysis of Options for Improving Rmap Access to the Mass Turnpike Extension Combined with Options for Downgrading Storrow Drive," April 30, 1991.

197. It should be noted again, that the projected increases in traffic are based on a fixed trip table and no-policy assumption. It has been argued in this paper beofre that this might not be a good assumption to start out with.

198. It should be noted, however, that both the Embarcadero Freeway in San Francisco as well as the Nimitz Freeway in Oakland were not rebuilt which could have had a substantial impact on BART ridership.

199. Stanley F. Moss, *Documentation of the Southwest Corridor Project*, 1989, Master's Thesis at UMass at Boston, p. 132.

200. ISTEA of 1991, *Section 2: Declaration of Policy*, House Record H11517.

201. Private correspondence with Fred Salvucci and Congressional Record of the Federal Transit Act Amendments of 1991, *Intermodal Surface Transportation Efficiency Act of 1991*, Section 1024: Metropolitan Planning, section (f) Factors To Be Considered, House Record H11530.

202. Maguire and Associates and Department of Public Works, *Master Highway Plan for the Boston Metropolitan Area*, 1948, p. 53.

203. The Federal Highway-Aid Act of 1962 indicated a widening of the scope of transportation planning to integrate some degree of community planning. See, for instance, Moss [1989], p. 66.

204. See, for instance, Alan Lupo, *Rites of Way*.

205. Indicative of this orientation is the great emphasis on meeting federal air quality standards which are currently being exceeded by far in Los Angeles.

206. "Boston may seek Olympics in 2004," *Boston Globe*, October 1, 1992.

207. The City of Los Angeles which hosted the Olympic Games in 1984, netted $3.3 billion according to the Globe article.

208. Organization for Economic Cooperation and Development (OECD), *Cities and Transport*, Chapter 7. Paris 1988.

209. "Boston May Seek Olympics in 2004," *Boston Globe*, October 1, 1992.

210. Boston Olympics Organizing Committee.

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APPENDIX

FIGURES AND TABLES

Location	1987 Link	1 1987 Count	2 CTPS 1987 Base	3 EMME/2 1987 Base	4 (3-1)/1 DIFF	5 CTPS 2010 Base	6 EMME/2 2010 Base	7 (6-3)/3 DIFF	2010 Link
Mass Ave Screenline									
On-ramp from Mass Ave to I-93									
Northbound	2525-2526	9,000	16,489	16,537	83.7%	n/a	16,790	1.5%	3587-2555
Off-ramp from I-93 to Mass Ave									
Southbound	2523-2524	12,500	19,640	19,494	56.0%	n/a	23,706	21.6%	2552-3586
Total		21,500	36,129	36,031	67.6%	n/a	40,496	12.4%	
Albany St E of Mass Ave									
Eastbound	2432-3133	9,000	5,379	5,513	-38.7%	5,810	5,465	-0.9%	
Westbound	3133-2432	8,000	3,845	4,121	-48.5%	5,613	5,384	30.6%	
Total		17,000	9,224	9,634	-43.3%	11,423	10,849	12.6%	
Harrison Ave E of Mass Ave									
Eastbound	2431-2430	6,200	3,615	3,670	-40.8%	4,531	4,166	13.5%	
Westbound	2430-2431	5,400	5,493	5,385	-0.3%	6,547	6,414	19.1%	
Total		11,600	9,108	9,055	-21.9%	11,078	10,580	16.8%	
Washington St E of Mass Ave									
Eastbound	2429-3151	6,800	2,474	2,270	-66.6%	4,481	3,908	72.2%	
Westbound	3151-2429	8,400	1,821	1,659	-80.3%	2,843	2,317	39.7%	
Total		15,200	4,295	3,929	-74.2%	7,324	6,225	58.4%	
Shawmut St E of Mass Ave									
Westbound	2427-2428	3,700	1,696	1,705	-53.9%	1,057	1,128	-33.8%	
Tremont St E of Mass Ave									
Eastbound	2426-2425	11,400	5,912	5,778	-49.3%	6,869	6,538	13.2%	
Westbound	2425-2426	9,700	5,848	5,903	-39.1%	9,255	8,457	43.3%	
Total		21,100	11,760	11,681	-44.6%	16,124	14,995	28.4%	
Columbus Ave E of Mass Ave									
Eastbound	2424-2370	6,000	7,637	7,320	22.0%	8,835	8,551	16.8%	
Westbound	2370-2424	7,600	8,331	8,358	10.0%	9,091	8,188	-2.0%	
Total		13,600	15,968	15,678	15.3%	17,926	16,739	6.8%	
Huntington St E of Mass Ave									
Eastbound	2423-2290	10,800	13,538	12,977	20.2%	13,976	12,648	-2.5%	
Westbound	2290-2423	11,300	15,810	15,219	34.7%	16,537	15,353	0.9%	
Total		22,100	29,348	28,196	27.6%	30,513	28,001	-0.7%	
Belvedere St E of Mass Ave									
Westbound	2293-2421	4,000	2,960	1,651	-58.7%	3,644	2,330	41.1%	
Boylston St E of Mass Ave									
Eastbound	2420-2245	12,700	6,011	6,619	-47.9%	7,826	8,300	25.4%	
Westbound	2245-2420	1,500	972	2,636	75.7%	786	2,537	-3.8%	
Total		14,200	6,983	9,255	-34.8%	8,612	10,837	17.1%	
Newbury St E of Mass Ave									
Westbound	3234-3236	7,200	3,519	4,892	-32.1%	2,536	3,756	-23.2%	
Comm Ave E of Mass Ave									
Eastbound Loc	3237-3109	4,300	589	548	-87.3%	856	950	73.4%	
Eastbound Thru	3421-3109	9,800	6,735	6,363	-35.1%	6,967	7,065	11.0%	
Westbound Loc	3108-3399	4,300	998	1,003	-76.7%	925	862	-14.1%	
Westbound Thru	3108-3238	8,500	6,031	6,194	-27.1%	8,365	7,846	26.7%	
Total		26,900	14,353	14,108	-47.6%	17,113	16,723	18.5%	
Marlborough St E of Mass Ave									
Eastbound	3401-3400	2,300	986	1,068	-53.6%	947	903	-15.4%	
Beacon St E of Mass Ave									
Westbound	3403-3402	12,800	4,402	3,959	-69.1%	6,026	5,599	41.4%	
Storrow Drive E of Mass Ave									
Eastbound	3404-2464	53,500	51,887	52,154	-2.5%	59,893	58,014	11.2%	3404-7000
Westbound	2463-3065	53,000	56,587	55,017	3.8%	61,377	60,664	10.3%	
Total		106,500	108,474	107,171	0.6%	121,270	118,678	10.7%	
Turnpike E of Mass Ave									
Eastbound	5488-3425	55,000	59,813	64,667	17.6%	77,118	80,277	24.1%	
Westbound	2408-2409	51,000	52,069	55,521	8.9%	70,205	72,728	31.0%	
Total		106,000	111,882	120,188	13.4%	147,323	153,005	27.3%	
TOTAL EASTBOUND		196,800	181,065	185,484	-5.8%	198,109	213,575	15.1%	
TOTAL WESTBOUND		208,900	190,022	192,717	-7.7%	204,807	227,269	17.9%	

Table 1.2-A1. 1987 and 2010 Screenline Counts and Assignment Volumes.(1/5)

Location	1987 Link	1 1987 Count	2 CTPS 1987 Base	3 EMME/2 1987 Base	4 (3-1)/1 DIFF	5 CTPS 2010 Base	6 EMME/2 2010 Base	7 (6-3)/3 DIFF	2010 Link
Berkeley St Screenline									
Frontage Road S of W. 4th St									
Northbound	2533-2532	30,000	35,419	38,561	28.5%	n/a	19,566	-49.3%	6338-6340
Albany S of E. Berkeley on-ramp									
Southbound	2545-2546	12,000	6,439	6,112	-49.1%	n/a	11,572	89.3%	6307-6308
Total		42,000	41,858	44,673	6.4%	n/a	31,138	-30.3%	
Harrison S of E. Berkeley									
Northbound	3143-2393	7,500	2,138	2,113	-71.8%	2,974	2,505	18.6%	
Southbound	2393-3143	5,000	2,812	2,795	-44.1%	5,259	4,394	57.2%	
Total		12,500	4,950	4,908	-60.7%	8,233	6,899	40.6%	
Washington S of E. Berkeley									
Northbound	3147-3146	6,000	1,213	1,237	-79.4%	3,166	2,370	91.6%	
Southbound	3146-3147	1,500	31	0	-100.0%	281	90		
Total		7,500	1,244	1,237	-83.5%	3,447	2,460	98.9%	
Shawmut S of E. Berkeley									
Northbound	3157-2387	1,500	0	0	-100.0%	0	0		
Tremont S of E. Berkeley									
Northbound	2379-2382	9,000	2,848	2,839	-68.5%	4,120	3,850	35.6%	
Southbound	2382-2379	11,000	6,015	6,052	-45.0%	8,825	7,811	29.1%	
Total		20,000	8,863	8,891	-55.5%	12,945	11,661	31.2%	
Warren W of Berkeley									
Eastbound	2380-2381	3,000	0	0	-100.0%	0	0		
Westbound	2381-2380	1,600	561	789	-50.7%	764	889	12.7%	
Total		4,600	561	789	-82.8%	764	889	12.7%	
Appleton W of Berkeley									
Eastbound	2361-2360	1,600	2,664	2,656	66.0%	2,577	2,610	-1.7%	
Chandler W of Berkeley									
Westbound	2357-2356	1,800	1,914	1,742	-3.2%	2,025	1,951	12.0%	
Columbus W of Berkeley									
Eastbound	2352-2349	7,400	3,409	3,425	-53.7%	3,860	3,858	12.6%	
Westbound	2349-2352	7,000	4,272	4,326	-38.2%	5,047	4,592	6.1%	
Total		14,400	7,681	7,751	-46.2%	8,907	8,450	9.0%	
Stuart W of Berkeley									
Eastbound	2315-2316	13,000	13,699	14,313	10.1%	13,481	13,485	-5.8%	
St. James W of Berkeley									
Westbound	2278-2279	14,000	12,032	11,685	-16.5%	11,758	12,390	6.0%	
Boylston W of Berkeley									
Eastbound	2251-2253	15,000	14,662	14,552	-3.0%	16,062	16,632	14.3%	
Newbury W of Berkeley									
Westbound	2450-2451	8,000	3,387	3,210	-59.9%	5,007	5,386	67.8%	
Comm Ave W of Berkeley									
Eastbound	2453-2440	12,000	7,943	7,118	-40.7%	10,873	11,057	55.3%	
Westbound	2439-2454	9,000	3,372	2,997	-66.7%	5,502	4,680	56.2%	
Total		21,000	11,315	10,115	-51.8%	16,375	15,737	55.6%	
Marlborough W of Berkeley									
Eastbound	2455-2437	5,000	1,070	1,076	-78.5%	1,063	1,100	2.2%	
Beacon W of Berkeley									
Westbound	2433-2458	15,000	12,082	12,752	-15.0%	13,080	12,773	0.2%	
Artery N of Mass Ave									
Northbound	2526-2558	67,000	83,777	81,563	21.7%	n/a	123,793	51.8%	2555-2556
Artery S of Albany on-ramp									
Southbound	2522-2523	100,500	101,104	102,147	1.6%	n/a	128,513	25.8%	6124-6125
Turnpike W of Artery									
Eastbound	2414-2415	42,000	44,565	48,057	14.4%	n/a	61,974	29.0%	2414-6333
Turnpike W of Arlington on-ramp									
Westbound	2406-2407	44,500	44,629	48,444	8.9%	62,828	65,663	35.5%	
Storrow E of Clarendon off-ramp									
Eastbound	2462-2311	48,000	46,607	47,346	-1.4%	54,683	53,252	12.5%	
Storrow E of Mass Ave									
Westbound	2463-3065	53,000	56,587	55,017	3.8%	61,377	60,664	10.3%	
TOTAL NORTH/EASTBOUND		268,000	260,014	265,645	-0.9%	112,859	316,941	19.3%	
TOTAL SOUTH/WESTBOUND		283,900	255,237	258,068	-9.1%	181,753	321,368	24.5%	

Table 1.2-A1. 1987 and 2010 Screenline Counts and Assignment Volumes.(2/5)

Location	1987 Link	1 1987 Count	2 CTPS 1987 Base	3 EMME/2 1987 Base	4 (3-1)/1 DIFF	5 CTPS 2010 Base	6 EMME/2 2010 Base	7 (6-3)/3 DIFF	2010 Link
Newbury St Screenline									
Hereford St N of Newbury									
Northbound	3234-3233	4,400	2,206	2,107	-52.1%	3,564	3,547	68.3%	
Gloucester N of Newbury									
Southbound	2793-2792	5,400	7,108	6,953	28.8%	7,349	7,217	3.8%	
Fairfield N of Newbury									
Northbound	2791-2790	3,100	5,390	5,359	72.9%	5,740	5,663	5.7%	
Exeter N of Newbury									
Southbound	2683-2682	8,500	4,350	4,042	-52.4%	5,583	5,000	23.7%	
Dartmouth N of Newbury									
Northbound	2679-2678	9,000	10,177	9,721	8.0%	13,340	13,402	37.9%	
Clarendon N of Newbury									
Southbound	2453-2452	11,500	15,017	15,469	34.5%	15,466	15,515	0.3%	
Berkeley N of Newbury									
Northbound	2443-2440	16,500	11,925	11,961	-27.5%	15,303	13,980	16.9%	
Arlington N of Newbury									
Southbound	2239-2238	26,000	22,257	21,846	-16.0%	22,353	21,561	-1.3%	
Charles S of Beacon									
Northbound	2255-2237	26,000	17,438	17,517	-32.6%	21,570	20,505	17.1%	
TOTAL NORTHBOUND		59,000	47,136	46,665	-20.9%	59,517	57,097	22.4%	
TOTAL SOUTHBOUND		51,400	48,732	48,310	-6.0%	50,751	49,293	2.0%	
State St Screenline									
Atlantic Ave N of State									
Northbound	1679-1878	15,000	6,402	6,616	-55.9%	n/a	8,067	21.9%	6197-6198
Southbound	1878-1679	11,000	8,137	8,224	-25.2%	n/a	n/a		
Total		26,000	14,539	14,840	-42.9%	n/a	8,067	-45.6%	
Surface Artery N of State									
Northbound	1677-1899	19,000	7,448	6,505	-65.8%	n/a	24,480	276.3%	6174-6175
Southbound	1899-1677	21,000	4,466	4,435	-78.9%	n/a	25,307	470.6%	6216-6217
Total		40,000	11,914	10,940	-72.7%	n/a	49,787	355.1%	
Congress St N of Court St									
Northbound	1672-2053	13,500	21,229	21,080	56.1%	22,293	21,974	4.2%	
Southbound	2053-1672	14,000	20,701	20,592	47.1%	23,807	22,978	11.6%	
Total		27,500	41,930	41,672	51.5%	46,100	44,952	7.9%	
Cambridge St N of Court St									
Northbound	1668-2176	9,000	5,813	5,399	-40.0%	6,847	6,671	23.6%	
Southbound	2176-1668	15,000	12,070	12,086	-19.4%	13,327	12,056	-0.2%	
Total		24,000	17,883	17,485	-27.1%	20,174	18,727	7.1%	
Artery N of Northern Ave on-ramp									
Northbound	1854-1855	99,000	93,961	93,969	-5.1%	n/a	107,309	14.2%	6282-6147
Artery S of Haymarket on-ramp									
Southbound	2044-1860	90,000	88,661	88,227	-2.0%	n/a	124,140	40.7%	6160-6161
Total		189,000	182,622	182,196	-3.6%	n/a	231,449	27.0%	
TOTAL NORTHBOUND		155,500	134,853	133,569	-14.1%	29,140	168,501	26.2%	
TOTAL SOUTHBOUND		151,000	134,035	133,564	-11.5%	37,134	184,481	38.1%	
Mystic Screenline									
Tobin Bridge									
Northbound	1840-1841	52,000	56,912	56,619	8.9%	69,276	68,906	21.7%	
Southbound	1652-1839	44,000	50,242	54,999	25.0%	61,260	63,968	16.3%	
Total		96,000	107,154	111,618	16.3%	130,536	132,874	19.0%	
Callahan Tunnel									
Eastbound	5499-5496	52,000	55,412	55,928	7.6%	44,437	43,043	-23.0%	
Sumner Tunnel									
Westbound	5497-5498	47,000	49,930	52,691	12.1%	41,517	44,819	-14.9%	
Total		99,000	105,342	108,619	9.7%	85,954	87,862	-19.1%	
TOTAL NORTH/EASTBOUND		104,000	112,324	112,547	8.2%	113,713	111,949	-0.5%	
TOTAL SOUTH/WESTBOUND		91,000	100,172	107,690	18.3%	102,777	108,787	1.0%	

Table 1.2-A1. 1987 and 2010 Screenline Counts and Assignment Volumes.(3/5)

Location	1987 Link	1 1987 Count	2 CTPS 1987 Base	3 EMME/2 1987 Base	4 (3-1)/1 DIFF	5 CTPS 2010 Base	6 EMME/2 2010 Base	7 (6-3)/3 DIFF	2010 Link
Charles River Crossings									
River St Bridge									
Eastbound	3112-4494			24,908		n/a	24,390	-2.1%	
Western Ave Bridge									
Westbound	4534-3114			21,691		n/a	20,983	-3.3%	
Total				46,599		n/a	45,373	-2.6%	
BU Bridge									
Northbound	4539-5514			20,230		n/a	20,725	2.4%	
Southbound	4420-4536			20,874		n/a	20,809	-0.3%	
Total				41,104		n/a	41,534	1.0%	
Harvard Bridge									
Northbound	3407-3408	10,000	12,150	11,393	13.9%	20,805	20,909	83.5%	
Southbound	3409-3410	10,000	12,080	12,052	20.5%	21,182	19,895	65.1%	
Total		20,000	24,230	23,445	17.2%	41,987	40,804	74.0%	
Longfellow Bridge									
Northbound	2160-2161	14,500	15,358	15,863	9.4%	16,939	16,671	5.1%	
Southbound	2162-2163	12,500	14,603	14,623	17.0%	17,068	16,963	16.0%	
Total		27,000	29,961	30,486	12.9%	34,007	33,634	10.3%	
Charles River Dam									
Northbound	2135-2136	20,000	21,203	21,410	7.1%	28,282	27,674	29.3%	
Southbound	2137-2138	26,000	28,922	30,387	16.9%	32,990	32,430	6.7%	
Total		46,000	50,125	51,797	12.6%	61,272	60,104	16.0%	
Artery Bridge									
Northbound	2113-1834	92,000	86,518	88,823	-3.5%	n/a	133,561	50.4%	6152-6153
Southbound	1833-2116	87,000	92,627	90,342	3.8%	n/a	140,087	55.1%	6156-6157
Total		179,000	179,145	179,165	0.1%	n/a	273,648	52.7%	
"Leverett Bridge"									
Northbound		n/a	n/a	n/a			73,685		6251-6447
Southbound		n/a	n/a	n/a			74,846		6444-6445
Total		n/a	n/a	n/a			148,531		
Charlestown Bridge									
Northbound	3395-3396	25,000	31,650	32,308	29.2%	33,611	32,282	-0.1%	
Southbound	3397-3398	27,000	30,826	31,464	16.5%	26,536	26,713	-15.1%	
Total		52,000	62,476	63,772	22.6%	60,147	58,995	-7.5%	
TOTAL NORTHBOUND		161,500	166,879	169,797	5.1%	99,637	142,651	-16.0%	
TOTAL SOUTHBOUND		162,500	179,058	178,868	10.1%	97,776	137,793	-23.0%	

Table 1.2-A1. 1987 and 2010 Screenline Counts and Assignment Volumes.(4/5)

Location	1987 Link	1 1987 Count	2 CTPS 1987 Base	3 EMME/2 1987 Base	4 (3-1)/1 DIFF	5 CTPS 2010 Base	6 EMME/2 2010 Base	7 (6-3)/3 DIFF	2010 Link
Mystic/Chelsea Screenline									
Bennington St W of Trident									
Eastbound	4010-2505	11,300	6,543	6,439	-43.0%	10,962	10,918	69.6%	
Westbound	2505-4010	12,100	5,821	5,986	-50.5%	8,993	10,107	68.8%	
Total		23,400	12,364	12,425	-46.9%	19,955	21,025	69.2%	
Route 1A @ Boston Revere Line									
Northbound	3791-3787	26,000	27,877	27,814	7.0%	33,970	33,966	22.1%	
Southbound	4756-3790	25,500	22,239	22,793	-10.6%	33,432	34,830	52.8%	
Total		51,500	50,116	50,607	-1.7%	67,402	68,796	35.9%	
Chelsea St Bridge									
Northbound	4044-4045	7,300	6,154	5,556	-23.9%	10,357	9,141	64.5%	
Southbound	3798-3799	7,600	8,705	8,253	8.6%	11,278	10,512	27.4%	
Total		14,900	14,859	13,809	-7.3%	21,635	19,653	42.3%	
McArdle Bridge									
Northbound	3794-3795	10,130	11,138	10,028	-1.0%	11,807	10,046	0.2%	
Southbound	3796-3797	9,700	10,256	10,309	6.3%	9,906	9,795	-5.0%	
Total		19,830	21,394	20,337	2.6%	21,713	19,841	-2.4%	
Tobin Bridge									
Northbound	1840-1841	52,000	56,912	56,619	8.9%	69,276	68,906	21.7%	
Southbound	1652-1839	44,000	50,242	54,999	25.0%	61,260	63,968	16.3%	
Total		96,000	107,154	111,618	16.3%	130,536	132,874	19.0%	
Route 99 N of Sullivan Sq									
Northbound	5166-5167	17,500	14,804	14,437	-17.5%	18,628	18,454	27.8%	
Southbound	5164-5165	23,500	19,900	16,154	-31.3%	22,932	19,888	23.1%	
Total		41,000	34,704	30,591	-25.4%	41,560	38,342	25.3%	
Route 28 S of Route 16									
Northbound	3602-3641	23,000	21,066	21,023	-8.6%	31,954	30,801	46.5%	
Southbound	3641-3602	23,000	25,517	23,602	2.6%	35,047	32,929	39.5%	
Total		46,000	46,583	44,625	-3.0%	67,001	63,730	42.8%	
I-93 N of Mystic Ave on-ramp									
Northbound	5220-5466	82,000	76,136	77,921	-5.0%	104,931	108,739	39.6%	
I-93 S of Route 16 off-ramp									
Southbound	5266-5219	77,500	79,646	80,135	3.4%	106,688	108,003	34.8%	
Total		159,500	155,782	158,056	-0.9%	211,619	216,742	37.1%	
Route 38 @ Medford/Somerville townline									
Northbound	3761-5441	14,000	845	716	-94.9%	3,389	2,312	222.9%	
Southbound	5441-3761	14,000	3,200	3,192	-77.2%	5,906	4,988	56.3%	
Total		28,000	4,045	3,908	-86.0%	9,295	7,300	86.8%	
TOTAL NORTH/EASTBOUND		243,230	221,475	220,553	-9.3%	295,274	293,283	33.0%	
TOTAL SOUTH/WESTBOUND		236,900	225,526	225,423	-4.8%	295,442	295,020	30.9%	

Table 1.2-A1. 1987 and 2010 Screenline Counts and Assignment Volumes.(5/5)

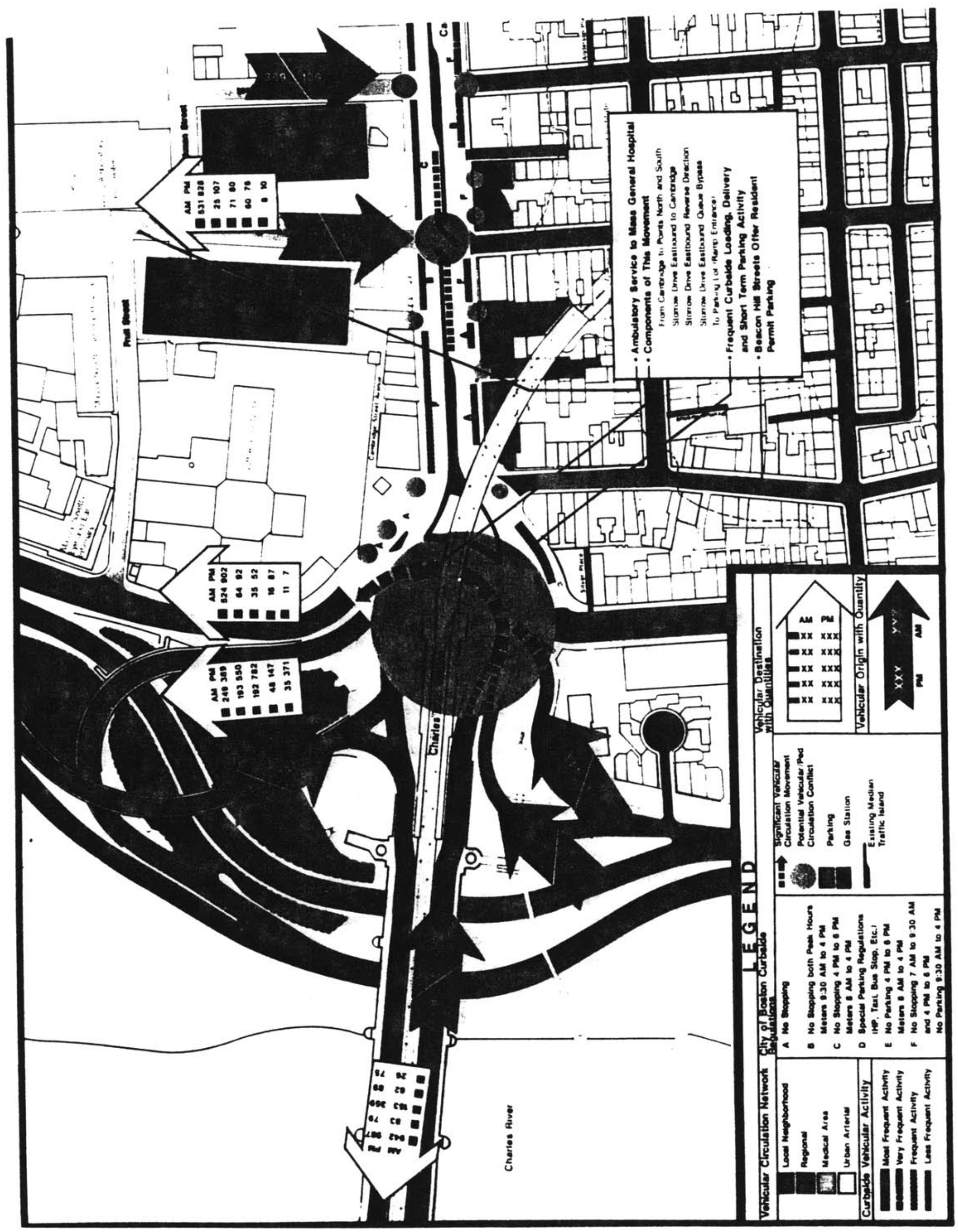

Figure 2.1-A1. 1987 Traffic Circulation and Peak Hour Volumes by O-D at Charles Circle.

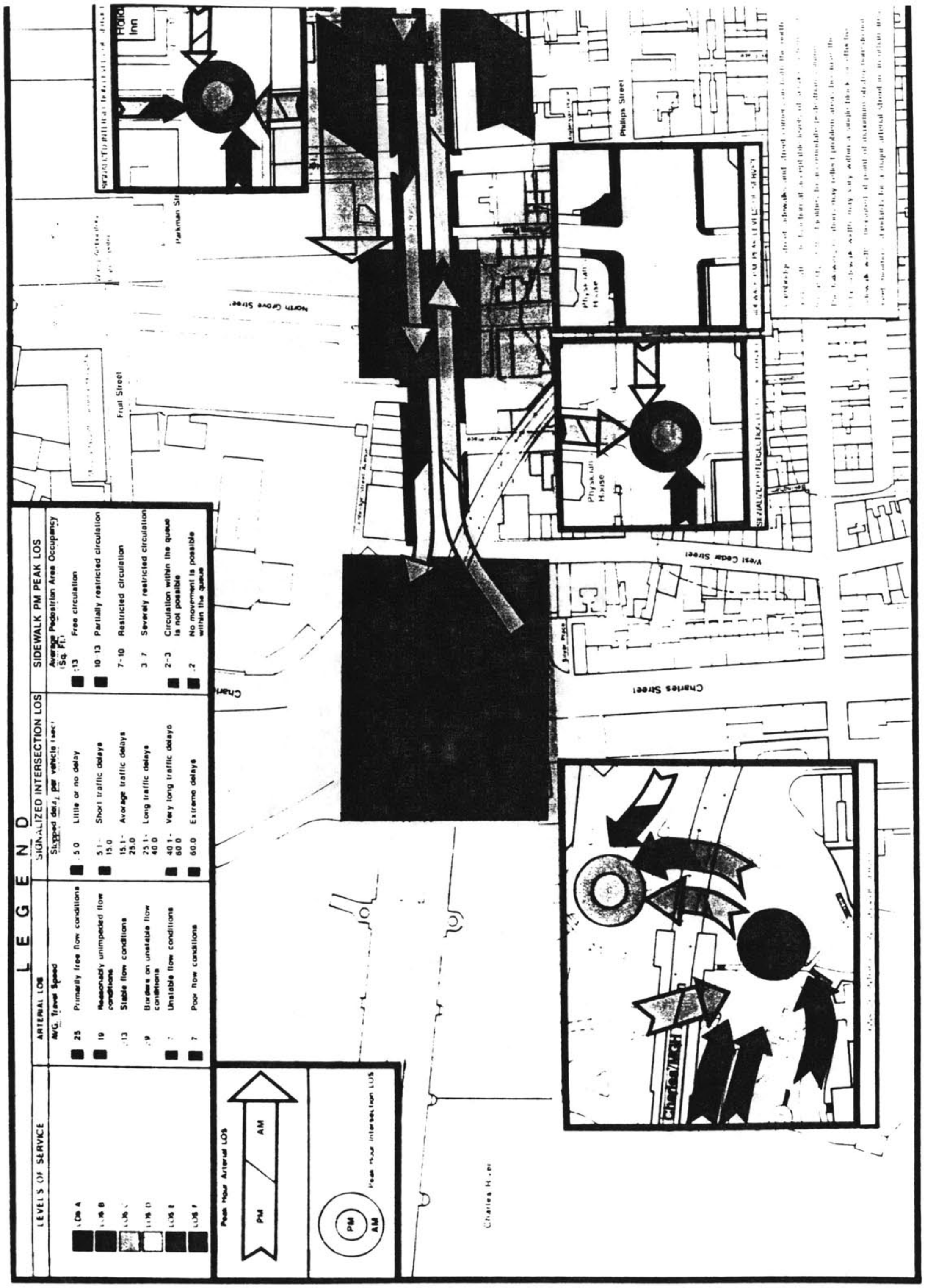

Figure 2.1-A2. 1987 Arterial, Intersection and Sidewalk LOS at Charles Circle.

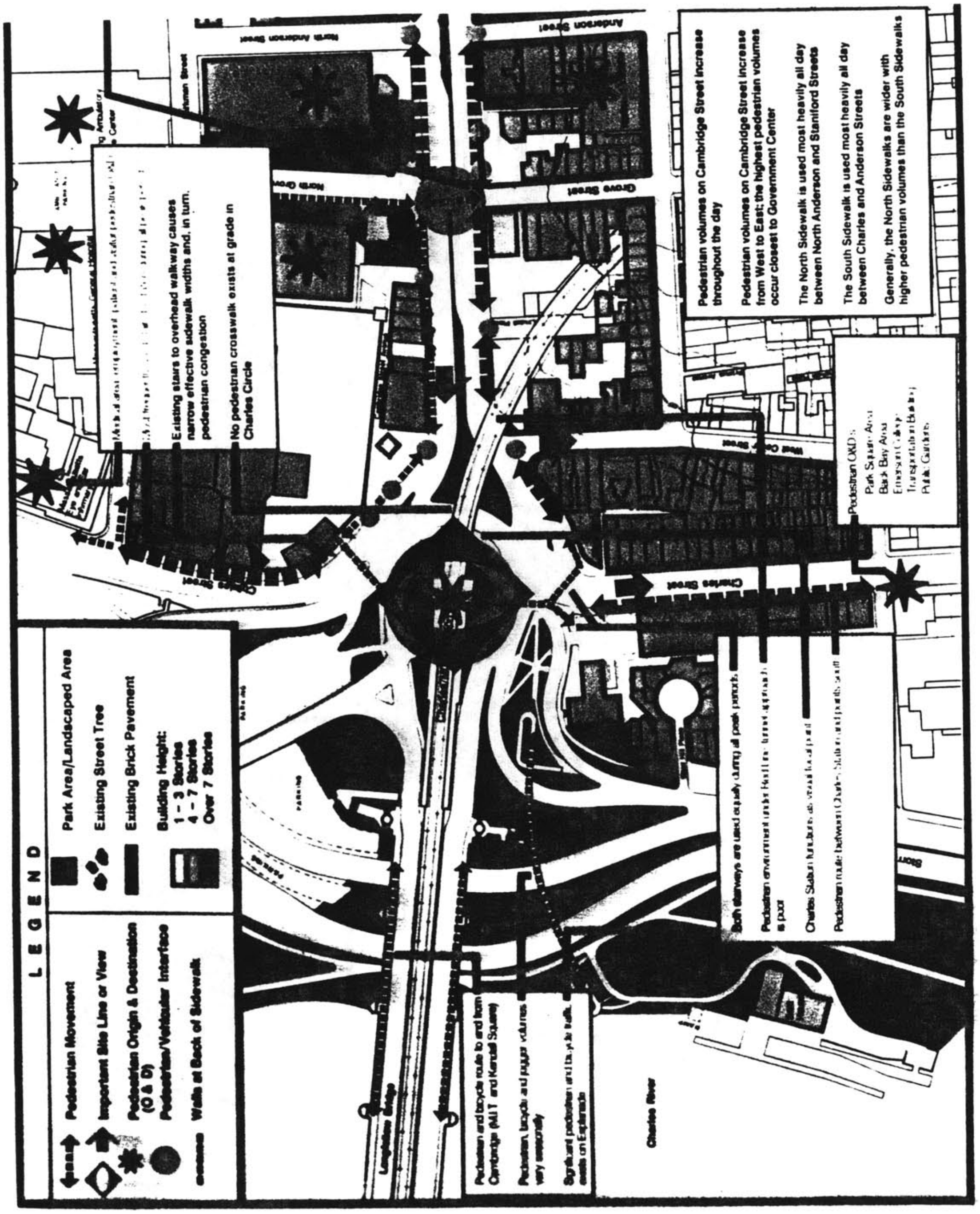

Figure 2.1-A3. Key Features of the Pedestrian Environment at Charles Circle.

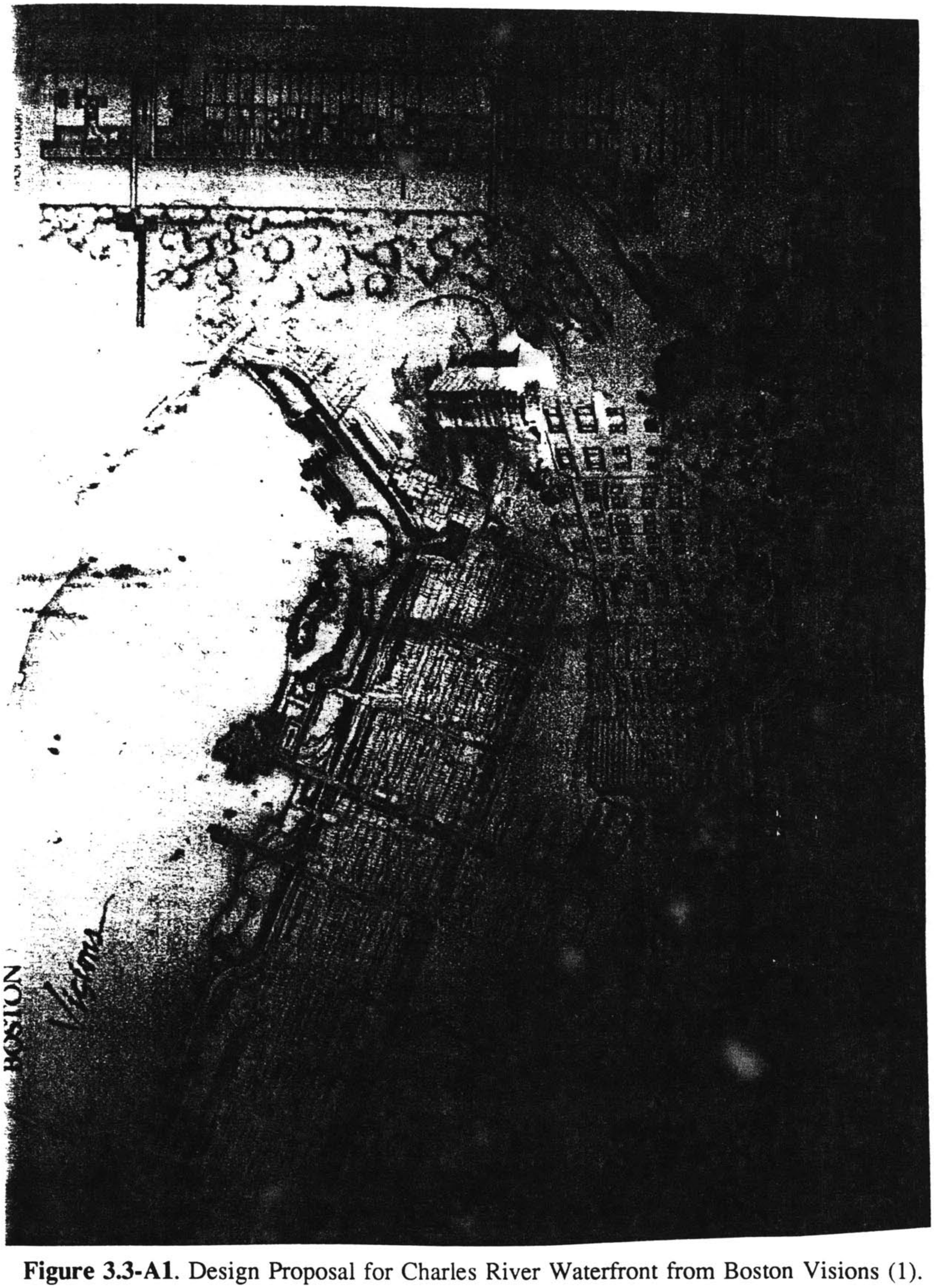

Figure 3.3-A1. Design Proposal for Charles River Waterfront from Boston Visions (1).

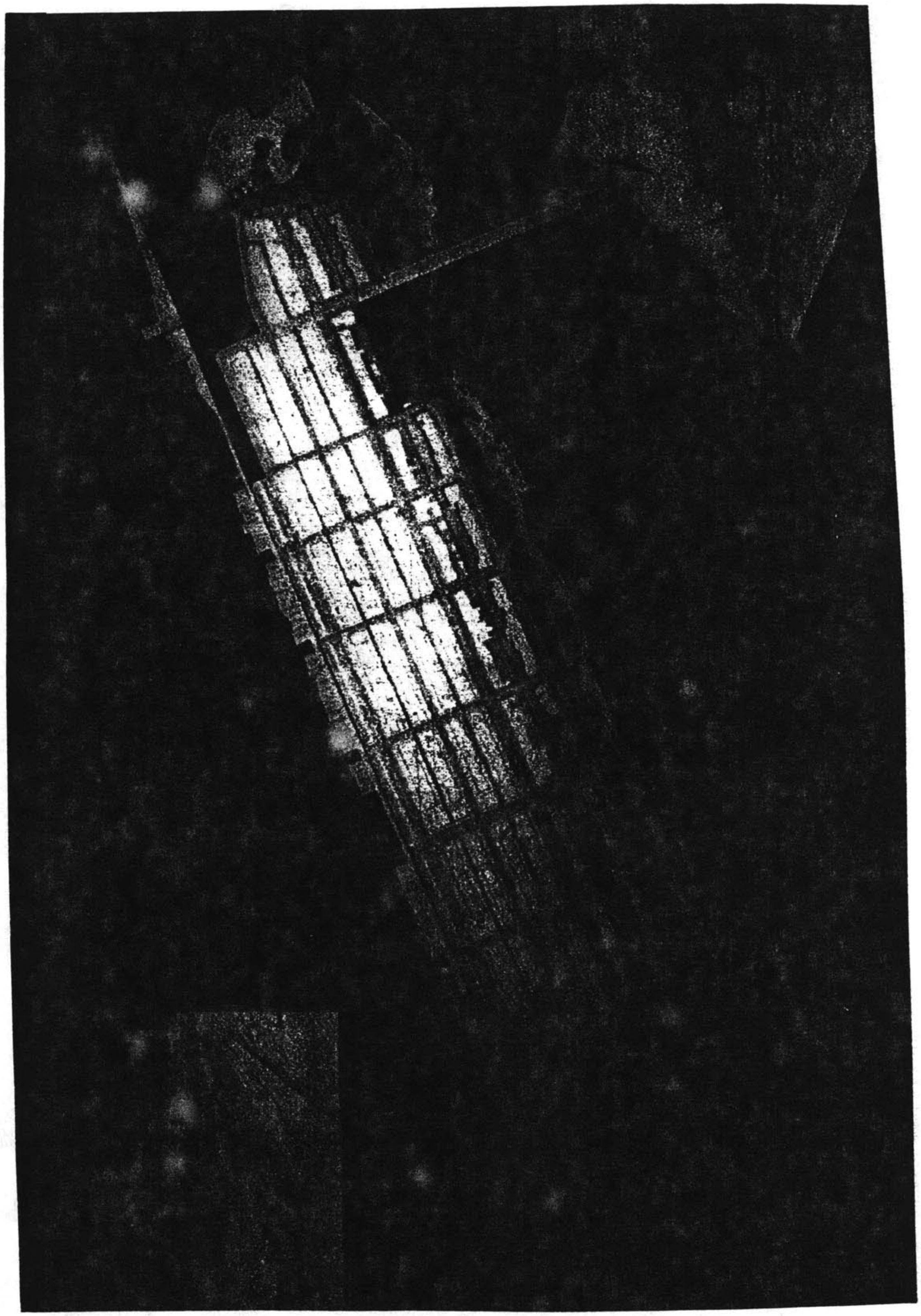

Figure 3.3-A2. Design Proposal for Charles River Waterfront from Boston Visions (2).

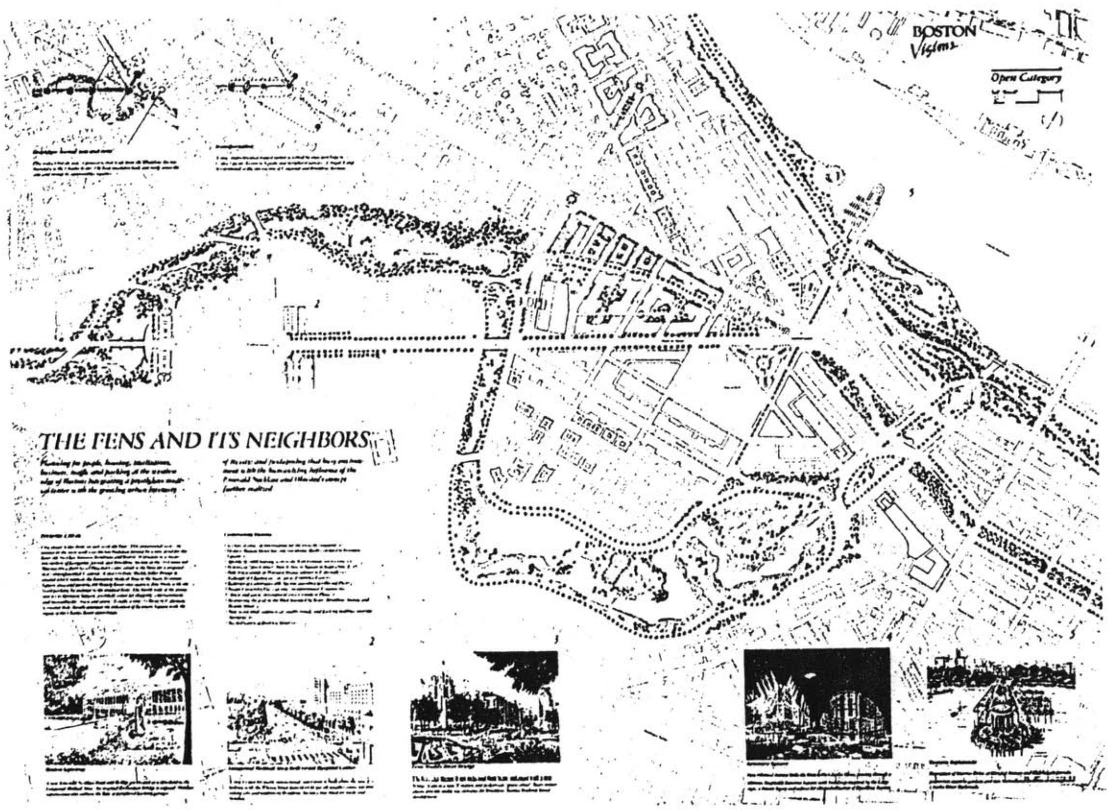

Figure 3.4-A1. Design Proposal for Charlesgate Entrance from Boston Visions.

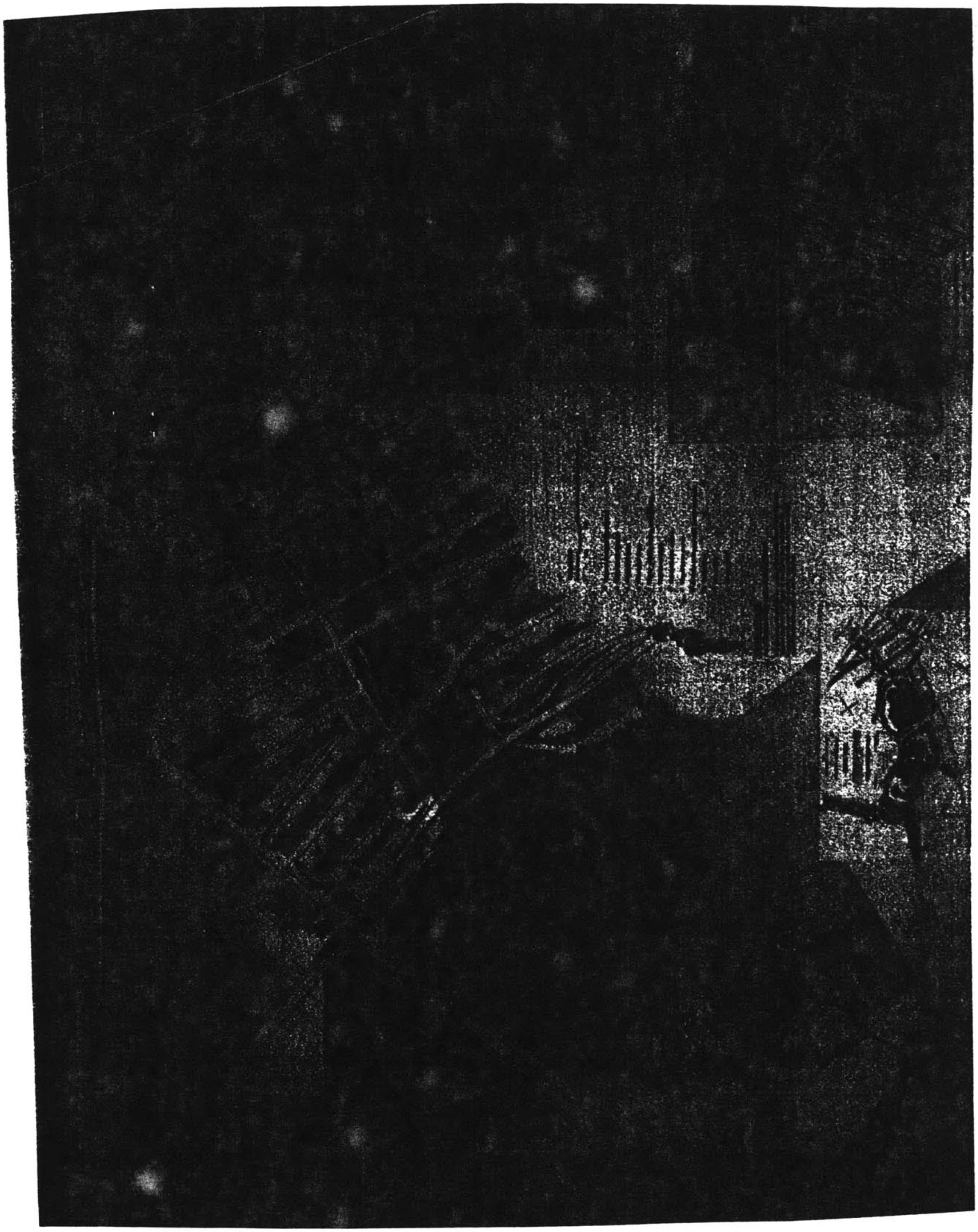

Figure 3.4-A2. Design Proposal for Back Bay Fens from MIT Architecture Studio.

Location	1987 Link	1 1987 Count	2 CTPS 1987 Base	3 EMME/2 1987 Base	4 CTPS 2010 Base	5 EMME/2 2010 Base	6 EMME/2 2010 MED	(6-5) DIFF	(6-5)/5 % DIFF	2010 Link
Mass Ave Screenline										
On-ramp from Mass Ave to I-93										
Northbound	2525-2526	9,000	16,489	16,537	n/a	16,790	17,335	545	3.2%	3587-2555
Off-ramp from I-93 to Mass Ave										
Southbound	2523-2524	12,500	19,640	19,494	n/a	23,706	20,720	-2,986	-12.6%	2552-3586
Total		21,500	36,129	36,031	n/a	40,496	38,055	-2,441	-6.0%	
Albany St E of Mass Ave										
Eastbound	2432-3133	9,000	5,379	5,513	5,810	5,465	6,588	1,123	20.5%	
Westbound	3133-2432	8,000	3,845	4,121	5,613	5,384	5,523	139	2.6%	
Total		17,000	9,224	9,634	11,423	10,849	12,111	1,262	11.6%	
Harrison Ave E of Mass Ave										
Eastbound	2431-2430	6,200	3,615	3,670	4,531	4,166	4,034	-132	-3.2%	
Westbound	2430-2431	5,400	5,493	5,385	6,547	6,414	6,414	0	0	
Total		11,600	9,108	9,055	11,078	10,580	10,448	-132	0	
Washington St E of Mass Ave										
Eastbound	2429-3151	6,800	2,474	2,270	4,481	3,908	4,102	194	5.0%	
Westbound	3151-2429	8,400	1,821	1,659	2,843	2,317	2,550	233	10.1%	
Total		15,200	4,295	3,929	7,324	6,225	6,652	427	6.9%	
Shawmut St E of Mass Ave										
Westbound	2427-2428	3,700	1,696	1,705	1,057	1,128	1,215	87	7.7%	
Tremont St E of Mass Ave										
Eastbound	2426-2425	11,400	5,912	5,778	6,869	6,538	6,260	-278	-4.3%	
Westbound	2425-2426	9,700	5,848	5,903	9,255	8,457	9,590	1,133	13.4%	
Total		21,100	11,760	11,681	16,124	14,995	15,850	855	5.7%	
Columbus Ave E of Mass Ave										
Eastbound	2424-2370	6,000	7,637	7,320	8,835	8,551	8,760	209	2.4%	
Westbound	2370-2424	7,600	8,331	8,358	9,091	8,188	8,551	363	4.4%	
Total		13,600	15,968	15,678	17,926	16,739	17,311	572	3.4%	
Huntington St E of Mass Ave										
Eastbound	2423-2290	10,800	13,538	12,977	13,976	12,648	13,048	400	3.2%	
Westbound	2290-2423	11,300	15,810	15,219	16,537	15,353	18,974	3,621	23.6%	
Total		22,100	29,348	28,196	30,513	28,001	32,022	4,021	14.4%	
Belvedere St E of Mass Ave										
Westbound	2293-2421	4,000	2,960	1,651	3,644	2,330	1,727	-603	-25.9%	
Boylston St E of Mass Ave										
Eastbound	2420-2245	12,700	6,011	6,619	7,826	8,300	12,206	3,906	47.1%	
Westbound	2245-2420	1,500	972	2,636	786	2,537	n/a			
Total		14,200	6,983	9,255	8,612	10,837	12,206	3,906	12.6%	
Newbury St E of Mass Ave										
Westbound	3234-3236	7,200	3,519	4,892	2,536	3,756	2,942	-814	-21.7%	
Comm Ave E of Mass Ave										
Eastbound Loc	3237-3109	4,300	589	548	856	950	1,627	677	71.3%	
Eastbound Thru	3421-3109	9,800	6,735	6,363	6,967	7,065	8,021	956	13.5%	
Westbound Loc	3108-3399	4,300	998	1,003	925	862	826	-36	-4.2%	
Westbound Thru	3108-3238	8,500	6,031	6,194	8,365	7,846	10,936	3,090	39.4%	
Total		26,900	14,353	14,108	17,113	16,723	21,410	4,687	28.0%	
Marlborough St E of Mass Ave										
Eastbound	3401-3400	2,300	986	1,068	947	903	857	-46	-5.1%	
Beacon St E of Mass Ave										
Westbound	3403-3402	12,800	4,402	3,959	6,026	5,599	8,861	3,262	58.3%	
Storrow Drive E of Mass Ave										
Eastbound	3404-2464	53,500	51,887	52,154	59,893	58,014	24,563	-33,451	-57.7%	3404-7000
Westbound	2463-3065	53,000	56,587	55,017	61,377	60,664	32,606	-28,058	-46.3%	
Total		106,500	108,474	107,171	121,270	118,678	57,169	-61,509	-51.8%	
Turnpike E of Mass Ave										
Eastbound	5488-3425	55,000	59,813	64,667	77,118	80,277	84,130	3,853	4.8%	
Westbound	2408-2409	51,000	52,069	55,521	70,205	72,728	78,017	5,289	7.3%	
Total		106,000	111,882	120,188	147,323	153,005	162,147	9,142	6.0%	
TOTAL EASTBOUND		196,800	181,065	185,484	198,109	213,575	191,531	-22,044	-10.3%	
TOTAL WESTBOUND		208,900	190,022	192,717	204,807	227,269	209,452	-17,817	-7.8%	

Table 4.3-A1. 2010 and MED SCHEME Screenline Assignment Volumes.(1/5)

Location	1987 Link	1 1987 Count	2 CTPS 1987 Base	3 EMME/2 1987 Base	4 CTPS 2010 Base	5 EMME/2 2010 Base	6 EMME/2 2010 MED	(6-5) DIFF	(6-5)/5 % DIFF	2010 Link
Berkeley St Screenline										
Frontage Road S of W. 4th St										
Northbound	2533-2532	30,000	35,419	38,561	n/a	19,566	24,565	4,999	25.5%	6338-6340
Albany S of E. Berkeley on-ramp										
Southbound	2545-2546	12,000	6,439	6,112	n/a	11,572	11,458	-114	-1.0%	6307-6308
Total		42,000	41,858	44,673	n/a	31,138	36,023	4,885	15.7%	
Harrison S of E. Berkeley										
Northbound	3143-2393	7,500	2,138	2,113	2,974	2,505	2,369	-136	-5.4%	
Southbound	2393-3143	5,000	2,812	2,795	5,259	4,394	4,440	46	1.0%	
Total		12,500	4,950	4,908	8,233	6,899	6,809	-90	-1.3%	
Washington S of E. Berkeley										
Northbound	3147-3146	6,000	1,213	1,237	3,166	2,370	2,506	136	5.7%	
Southbound	3146-3147	1,500	31	0	281	90	265	175	194.4%	
Total		7,500	1,244	1,237	3,447	2,460	2,771	311	12.6%	
Shawmut S of E. Berkeley										
Northbound	3157-2387	1,500	0	0	0	0	0	0		
Tremont S of E. Berkeley										
Northbound	2379-2382	9,000	2,848	2,839	4,120	3,850	3,413	-437	-11.4%	
Southbound	2382-2379	11,000	6,015	6,052	8,825	7,811	8,826	1,015	13.0%	
Total		20,000	8,863	8,891	12,945	11,661	12,239	578	5.0%	
Warren W of Berkeley										
Eastbound	2380-2381	3,000	0	0	0	0	0	0	0.0%	
Westbound	2381-2380	1,600	561	789	764	889	751	-138	-15.5%	
Total		4,600	561	789	764	889	751	-138	-15.5%	
Appleton W of Berkeley										
Eastbound	2361-2360	1,600	2,664	2,656	2,577	2,610	2,326	-284	-10.9%	
Chandler W of Berkeley										
Westbound	2357-2356	1,800	1,914	1,742	2,025	1,951	2,132	181	9.3%	
Columbus W of Berkeley										
Eastbound	2352-2349	7,400	3,409	3,425	3,860	3,858	3,707	-151	-3.9%	
Westbound	2349-2352	7,000	4,272	4,326	5,047	4,592	4,144	-448	-9.8%	
Total		14,400	7,681	7,751	8,907	8,450	7,851	-599	-7.1%	
Stuart W of Berkeley										
Eastbound	2315-2316	13,000	13,699	14,313	13,481	13,485	16,216	2,731	20.3%	
St. James W of Berkeley										
Westbound	2278-2279	14,000	12,032	11,685	11,758	12,390	13,395	1,005	8.1%	
Boylston W of Berkeley										
Eastbound	2251-2253	15,000	14,662	14,552	16,062	16,632	17,632	1,000	6.0%	
Newbury W of Berkeley										
Westbound	2450-2451	8,000	3,387	3,210	5,007	5,386	5,699	313	5.8%	
Comm Ave W of Berkeley										
Eastbound	2453-2440	12,000	7,943	7,118	10,873	11,057	11,572	515	4.7%	
Westbound	2439-2454	9,000	3,372	2,997	5,502	4,680	7,305	2,625	56.1%	
Total		21,000	11,315	10,115	16,375	15,737	18,877	3,140	20.0%	
Marlborough W of Berkeley										
Eastbound	2455-2437	5,000	1,070	1,076	1,063	1,100	907	-193	-17.5%	
Beacon W of Berkeley										
Westbound	2433-2458	15,000	12,082	12,752	13,080	12,773	5,424	-7,349	-57.5%	
Artery N of Mass Ave										
Northbound	2526-2558	67,000	83,777	81,563	n/a	123,793	128,995	5,202	4.2%	2555-2556
Artery S of Albany on-ramp										
Southbound	2522-2523	100,500	101,104	102,147	n/a	128,513	124,303	-4,210	-3.3%	6124-6125
Turnpike W of Artery										
Eastbound	2414-2415	42,000	44,565	48,057	n/a	61,974	65,724	3,750	6.1%	2414-6333
Turnpike W of Arlington on-ramp										
Westbound	2406-2407	44,500	44,629	48,444	62,828	65,663	70,665	5,002	7.6%	
Storrow E of Clarendon off-ramp										
Eastbound	2462-2311	48,000	46,607	47,346	54,683	53,252	21,724	-31,528	-59.2%	
Storrow E of Mass Ave										
Westbound	2463-3065	53,000	56,587	55,017	61,377	60,664	32,606	-28,058	-46.3%	
TOTAL NORTH/EASTBOUND		268,000	260,014	265,645	112,859	316,941	302,407	-14,534	-4.6%	
TOTAL SOUTH/WESTBOUND		283,900	255,237	258,068	181,753	321,368	291,413	-29,955	-9.3%	

Table 4.3-A1. 2010 and MED SCHEME Screenline Assignment Volumes.(2/5)

Location	1987 Link	1 1987 Count	2 CTPS 1987 Base	3 EMME/2 1987 Base	4 CTPS 2010 Base	5 EMME/2 2010 Base	6 EMME/2 2010 MED	(6-5) DIFF	(6-5)/5 % DIFF	2010 Link
Newbury St Screenline										
Hereford St N of Newbury										
Northbound	3234-3233	4,400	2,206	2,107	3,564	3,547	6,960	3,413	96.2%	
Gloucester N of Newbury										
Southbound	2793-2792	5,400	7,108	6,953	7,349	7,217	8,002	785	10.9%	
Fairfield N of Newbury										
Northbound	2791-2790	3,100	5,390	5,359	5,740	5,663	6,338	675	11.9%	
Exeter N of Newbury										
Southbound	2683-2682	8,500	4,350	4,042	5,583	5,000	8,467	3,467	69.3%	
Dartmouth N of Newbury										
Northbound	2679-2678	9,000	10,177	9,721	13,340	13,402	10,679	-2,723	-20.3%	
Clarendon N of Newbury										
Southbound	2453-2452	11,500	15,017	15,469	15,466	15,515	11,900	-3,615	-23.3%	
Berkeley N of Newbury										
Northbound	2443-2440	16,500	11,925	11,961	15,303	13,980	12,300	-1,680	-12.0%	
Arlington N of Newbury										
Southbound	2239-2238	26,000	22,257	21,846	22,353	21,561	18,453	-3,108	-14.4%	
Charles S of Beacon										
Northbound	2255-2237	26,000	17,438	17,517	21,570	20,505	18,069	-2,436	-11.9%	
TOTAL NORTHBOUND		59,000	47,136	46,665	59,517	57,097	54,346	-2,751	-4.8%	
TOTAL SOUTHBOUND		51,400	48,732	48,310	50,751	49,293	46,822	-2,471	-5.0%	
State St Screenline										
Atlantic Ave N of State										
Northbound	1679-1878	15,000	6,402	6,616	n/a	8,067	9,651	1,584	19.6%	6197-6198
Southbound	1878-1679	11,000	8,137	8,224	n/a	n/a	n/a	n/a	n/a	
Total		26,000	14,539	14,840	n/a	8,067	9,651	1,584	19.6%	
Surface Artery N of State										
Northbound	1677-1899	19,000	7,448	6,505	n/a	24,480	27,217	2,737	11.2%	6174-6175
Southbound	1899-1677	21,000	4,466	4,435	n/a	25,307	26,928	1,621	6.4%	6216-6217
Total		40,000	11,914	10,940	n/a	49,787	54,145	4,358	8.8%	
Congress St N of Court St										
Northbound	1672-2053	13,500	21,229	21,080	22,293	21,974	22,650	676	3.1%	
Southbound	2053-1672	14,000	20,701	20,592	23,807	22,978	24,781	1,803	7.8%	
Total		27,500	41,930	41,672	46,100	44,952	47,431	2,479	5.5%	
Cambridge St N of Court St										
Northbound	1668-2176	9,000	5,813	5,399	6,847	6,671	6,948	277	4.2%	
Southbound	2176-1668	15,000	12,070	12,086	13,327	12,056	15,746	3,690	30.6%	
Total		24,000	17,883	17,485	20,174	18,727	22,694	3,967	21.2%	
Artery N of Northern Ave on-ramp										
Northbound	1854-1855	99,000	93,961	93,969	n/a	107,309	112,234	4,925	4.6%	6282-6147
Artery S of Haymarket on-ramp										
Southbound	2044-1860	90,000	88,661	88,227	n/a	124,140	125,755	1,615	1.3%	6160-6161
Total		189,000	182,622	182,196	n/a	231,449	237,989	6,540	2.8%	
TOTAL NORTHBOUND		155,500	134,853	133,569	29,140	168,501	178,700	10,199	6.1%	
TOTAL SOUTHBOUND		151,000	134,035	133,564	37,134	184,481	193,210	8,729	4.7%	
Mystic Screenline										
Tobin Bridge										
Northbound	1840-1841	52,000	56,912	56,619	69,276	68,906	67,426	-1,480	-2.1%	
Southbound	1652-1839	44,000	50,242	54,999	61,260	63,968	63,396	-572	-0.9%	
Total		96,000	107,154	111,618	130,536	132,874	130,822	-2,052	-1.5%	
Callahan Tunnel										
Eastbound	5499-5496	52,000	55,412	55,928	44,437	43,043	41,093	-1,950	-4.5%	
Sumner Tunnel										
Westbound	5497-5498	47,000	49,930	52,691	41,517	44,819	43,658	-1,161	-2.6%	
Total		99,000	105,342	108,619	85,954	87,862	84,751	-3,111	-3.5%	
TOTAL NORTH/EASTBOUND		104,000	112,324	112,547	113,713	111,949	108,519	-3,430	-3.1%	
TOTAL SOUTH/WESTBOUND		91,000	100,172	107,690	102,777	108,787	107,054	-1,733	-1.6%	

Table 4.3-A1. 2010 and MED SCHEME Screenline Assignment Volumes.(3/5)

		1	2	3	4	5	6			
			CTPS	EMME/2	CTPS	EMME/2	EMME/2			
	1987	1987	1987	1987	2010	2010	2010	(6-5)	(6-5)/5	2010
Location	Link	Count	Base	Base	Base	Base	MED	DIFF	% DIFF	Link
Charles River Crossings										
River St Bridge										
Eastbound	3112-4494			24,908	n/a	24,390	29,302	4,912	20.1%	
Western Ave Bridge										
Westbound	4534-3114			21,691	n/a	20,983	25,017	4,034	19.2%	
Total				46,599	n/a	45,373	54,319	8,946	19.7%	
BU Bridge										
Northbound	4539-5514			20,230	n/a	20,725	22,376	1,651	8.0%	
Southbound	4420-4536			20,874	n/a	20,809	22,732	1,923	9.2%	
Total				41,104	n/a	41,534	45,108	3,574	8.6%	
Harvard Bridge										
Northbound	3407-3408	10,000	12,150	11,393	20,805	20,909	26,730	5,821	27.8%	
Southbound	3409-3410	10,000	12,080	12,052	21,182	19,895	22,280	2,385	12.0%	
Total		20,000	24,230	23,445	41,987	40,804	49,010	8,206	20.1%	
Longfellow Bridge										
Northbound	2160-2161	14,500	15,358	15,863	16,939	16,671	21,020	4,349	26.1%	
Southbound	2162-2163	12,500	14,603	14,623	17,068	16,963	23,431	6,468	38.1%	
Total		27,000	29,961	30,486	34,007	33,634	44,451	10,817	32.2%	
Charles River Dam										
Northbound	2135-2136	20,000	21,203	21,410	28,282	27,674	26,495	-1,179	-4.3%	
Southbound	2137-2138	26,000	28,922	30,387	32,990	32,430	30,556	-1,874	-5.8%	
Total		46,000	50,125	51,797	61,272	60,104	57,051	-3,053	-5.1%	
Artery Bridge										
Northbound	2113-1834	92,000	86,518	88,823	n/a	133,561	136,595	3,034	2.3%	6152-6153
Southbound	1833-2116	87,000	92,627	90,342	n/a	140,087	140,038	-49	0.0%	6156-6157
Total		179,000	179,145	179,165	n/a	273,648	276,633	2,985	1.1%	
"Leverett Bridge"										
Northbound		n/a	n/a	n/a		73,685	58,918			6251-6447
Southbound		n/a	n/a	n/a		74,846	71,170			6444-6445
Total		n/a	n/a	n/a		148,531	130,088			
Charlestown Bridge										
Northbound	3395-3396	25,000	31,650	32,308	33,611	32,282	33,206	924	2.9%	
Southbound	3397-3398	27,000	30,826	31,464	26,536	26,713	25,956	-757	-2.8%	
Total		52,000	62,476	63,772	60,147	58,995	59,162	167	0.3%	
TOTAL NORTHBOUND		161,500	166,879	169,797	99,637	142,651	159,129	16,478	11.6%	
TOTAL SOUTHBOUND		162,500	179,058	178,868	97,776	137,793	149,972	12,179	8.8%	

Table 4.3-A1. 2010 and MED SCHEME Screenline Assignment Volumes.(4/5)

Location	1987 Link	1 1987 Count	2 CTPS 1987 Base	3 EMME/2 1987 Base	4 CTPS 2010 Base	5 EMME/2 2010 Base	6 EMME/2 2010 MED	(6-5) DIFF	(6-5)/5 % DIFF	2010 Link
Mystic/Chelsea Screenline										
Bennington St W of Trident										
Eastbound	4010-2505	11,300	6,543	6,439	10,962	10,918	10,975	57	0.5%	
Westbound	2505-4010	12,100	5,821	5,986	8,993	10,107	10,256	149	1.5%	
Total		23,400	12,364	12,425	19,955	21,025	21,231	206	1.0%	
Route 1A @ Boston Revere Line										
Northbound	3791-3787	26,000	27,877	27,814	33,970	33,966	33,629	-337	-1.0%	
Southbound	4756-3790	25,500	22,239	22,793	33,432	34,830	33,475	-1,355	-3.9%	
Total		51,500	50,116	50,607	67,402	68,796	67,104	-1,692	-2.5%	
Chelsea St Bridge										
Northbound	4044-4045	7,300	6,154	5,556	10,357	9,141	10,040	899	9.8%	
Southbound	3798-3799	7,600	8,705	8,253	11,278	10,512	11,874	1,362	13.0%	
Total		14,900	14,859	13,809	21,635	19,653	21,914	2,261	11.5%	
McArdle Bridge										
Northbound	3794-3795	10,130	11,138	10,028	11,807	10,046	10,051	5	0.0%	
Southbound	3796-3797	9,700	10,256	10,309	9,906	9,795	9,618	-177	-1.8%	
Total		19,830	21,394	20,337	21,713	19,841	19,669	-172	-0.9%	
Tobin Bridge										
Northbound	1840-1841	52,000	56,912	56,619	69,276	68,906	67,426	-1,480	-2.1%	
Southbound	1652-1839	44,000	50,242	54,999	61,260	63,968	63,396	-572	-0.9%	
Total		96,000	107,154	111,618	130,536	132,874	130,822	-2,052	-1.5%	
Route 99 N of Sullivan Sq										
Northbound	5166-5167	17,500	14,804	14,437	18,628	18,454	18,594	140	0.8%	
Southbound	5164-5165	23,500	19,900	16,154	22,932	19,888	20,440	552	2.8%	
Total		41,000	34,704	30,591	41,560	38,342	39,034	692	1.8%	
Route 28 S of Route 16										
Northbound	3602-3641	23,000	21,066	21,023	31,954	30,801	30,974	173	0.6%	
Southbound	3641-3602	23,000	25,517	23,602	35,047	32,929	32,468	-461	-1.4%	
Total		46,000	46,583	44,625	67,001	63,730	63,442	-288	-0.5%	
I-93 N of Mystic Ave on-ramp										
Northbound	5220-5466	82,000	76,136	77,921	104,931	108,739	108,617	-122	-0.1%	
I-93 S of Route 16 off-ramp										
Southbound	5266-5219	77,500	79,646	80,135	106,688	108,003	107,962	-41	0.0%	
Total		159,500	155,782	158,056	211,619	216,742	216,579	-163	-0.1%	
Route 38 @ Medford/Somerville townline										
Northbound	3761-5441	14,000	845	716	3,389	2,312	2,654	342	14.8%	
Southbound	5441-3761	14,000	3,200	3,192	5,906	4,988	4,988	0	0.0%	
Total		28,000	4,045	3,908	9,295	7,300	7,642	342	4.7%	
TOTAL NORTH/EASTBOUND		243,230	221,475	220,553	295,274	293,283	292,960	-323	-0.1%	
TOTAL SOUTH/WESTBOUND		236,900	225,526	225,423	295,442	295,020	294,477	-543	-0.2%	

Table 4.3-A1. 2010 and MED SCHEME Screenline Assignment Volumes.(5/5)

Element 1: Improved Allston Interchnage

Simulation Objective: Create connection between Soldiers Field Road and Mass Turnpike which has same capacity and speed characteristics as Soldiers Field Road in that location

Step 1: Create new connection

1. add nodes	8000	8001	(see supporting plot for location of nodes)
2. add links	*5417-8000*	*8001-1824*	(same characteristics as SFR)
type	*216*	*216*	
lanes	2	2	these are prototypes of
cap/ln	*1700*	*1700*	Soldiers Field Road Links
ffs	*45*	*45*	
code	6	6	

3. forbid new turns

at node	from node	to node
1824	8001	3112
5417	3111	8000
5481	8001	8000

Step 2: Modify existing connection

1. modify connections between nodes where new nodes were inserted

	link	type	lanes	cap/ln	ffs	code
old						
	5481-5480	266	2	1200	35	101
	5482-5481	264	1	1800	25	101
new	link	type	lanes	cap/ln	ffs	code
	5481-8000	264	2	900	25	6
	8001-5481	264	2	900	25	6
	8000-5480	271	3	1200	45	6
	5482-8001	271	3	1200	45	6

2. modify links leading from new connection to TP Extension

	link	type	lanes	cap/ln	ffs	code	
old							
	5480-1650	268	2	1200	10	101	toll link
	1650-1651	267	7	9999	60	101	calib link
	1651-5484	265	1	2100	30	101	
	5483-1658	268	2	1200	10	101	toll link
	1658-1659	267	7	9999	60	101	calib link
	1659-5482	265	1	2100	30	101	
new	link	type	lanes	cap/ln	ffs	code	
	5480-1650	*216*	2	*1700*	*45*	6	toll link
	1650-1651	267	7	9999	60	6	calib link
	1651-5484	*216*	2	*1700*	*45*	6	
	5483-1658	*216*	2	*1700*	*45*	6	toll link
	1658-1659	267	7	9999	60	6	calib link
	1659-5482	*216*	2	*1700*	*45*	6	

Step 3: Delete old links

1. 5481-5480
2. 5482-5481

Sources: Tom Lisco's Memorandum "Preliminary Analysis...." from April 30,1991.

Table 5-A1. Description of Network Manipulations to Simulate Turnpike Upgrade.(1/2)

Element 2: Elimination of Tolls

Simulation Objective: Modify toll links to and from Boston Extension for entering/exiting traffic at Beacon Park so they have same characteristics as normal links

Step 1: Identify links	link	length	toll	wait time	ffs	distance penalty	adjusted length
1. toll links	5480-1650	0.12 mi	$0.35	30 sec.	10 mph	0.37 mi*	0.49 mi
	5483-1658	0.06 mi	$0.35	30 sec.	10 mph	0.37 mi*	0.43 mi

* calculated based on value of time of $12/hour

Step 2: Remove tolls from link attributes	link	length	toll	wait time	ffs	distance penalty	adjusted length
1. new links	5480-1650	0.12 mi	0	0	*45 mph***	0	*0.12 mi***
	5483-1658	0.06 mi	0	0	*45 mph***	0	*0.06 mi***

** these are the values used for the improved Allston links in #1

Sources: Cambridge Systematics, "Detailed Travel Model Description," 1991.

Element 3: Add Kenmore Square, Berkeley and Arlington ramps

Simulation Objective: Code additional links directly into network

Step 1: Kenmore Square

1. add nodes 6701 to 6710

2. add links	link	lanes	cap/ln	ffs	ramp location
#1	6706-6707	1	1500	20	TP EB to Beacon St
#2	6704-6705	1	1800	25	Beacon St to TP WB
#3	6709-6710	1	1800	25	Brookline Ave to TP EB
#4	6700-6701	1	1500	20	TP EB to Brookline Ave

3. connect	link	lanes	cap/ln	ffs	location
	6707-6708	2	500	10	Beacon St WB to Beacon St EB @ TP ramp #1
	6703-6704	1	500	10	Beacon St EB to Beacon St WB @ TP ramp #2

Step 2: Berkeley and Arlington ramps

1. add nodes 6720 to 6723

2. add links	link	lanes	cap/ln	ffs	ramp location
	6723-2414	1	1800	25	Arlington St to TP EB
	6720-6721	1	1800	25	TP WB to Berkeley St
	6721-6722	1	1500	15	TP WB to Berkeley St

Sources: Vollmer Associates, unpublished memoranda on ramp configuration and capacities
additional info derived from Eduardo Pereira (CTPS) memo on link types and characteristics

Table 5-A1. Description of Network Manipulations to Simulate Turnpike Upgrade (2/2).

	Scenario	Base 1987	Base 2010	MED 3012	FULL 3013	LOW 3011	Policy 1 4012	Policy 2 5012	Policy 3 6012
Southeast									
Morrissey Blvd N of Dudley St									
Northbound	2798-3805	17,260	29,400	23,967	27,328	25,053	30,593	25,929	28,362
Southbound	3804-3005	15,828	27,140	26,958	25,803	28,190	29,699	26,155	26,014
Total		33,088	56,540	50,925	53,131	53,243	60,292	52,084	54,376
I-93 S of Mass Ave exit									
Northbound	1702-1704	91,055	108,313	113,023	109,957	112,081	107,044	109,450	108,888
Southbound	1715-1716	91,552	111,079	111,552	111,985	109,839	108,452	111,546	110,107
Total		182,607	219,392	224,575	221,942	221,920	215,496	220,996	218,995
Seaver St N of Blue Hill Ave									
Northbound	3029-1641	13,604	15,741	15,773	15,135	15,707	15,610	13,869	15,919
Southbound	1641-3029	13,906	15,814	15,726	15,834	15,645	15,832	15,470	15,278
Total		27,510	31,555	31,499	30,969	31,352	31,442	29,339	31,197
Southwest									
Huntington Ave E of Jamaicaway									
Eastbound	2717-2716	19,909	21,584	21,619	21,012	21,504	21,789	19,949	21,808
Westbound	2716-2717	17,479	21,554	18,888	19,044	18,213	18,615	19,118	17,174
Total		37,388	43,138	40,507	40,056	39,717	40,404	39,067	38,982
Jamaicaway N of Huntington									
Northbound	2718-2725	18,366	20,859	19,349	18,970	20,384	19,294	18,253	19,609
Southbound	2725-2718	18,136	20,213	18,975	18,354	20,156	19,909	18,014	18,542
Total		36,502	41,072	38,324	37,324	40,540	39,203	36,267	38,151
Beacon St E of Harvard Ave									
Eastbound	5316-5314	8,601	12,596	11,119	10,291	11,115	13,001	10,642	11,122
Westbound	5314-5316	6,994	10,316	9,198	9,658	9,372	10,303	8,647	7,284
Total		15,595	22,912	20,317	19,949	20,487	23,304	19,289	18,406
West									
Turnpike E of Beacon Park									
Eastbound	5484-5485	64,667	80,277	84,130	85,663	81,025	91,826	75,864	83,435
Westbound	5486-5483	58,823	76,658	80,543	82,661	76,359	86,934	79,791	79,523
Total		123,490	156,935	164,673	168,324	157,384	178,760	155,655	162,958
Soldiers Field Road S of Western Ave Bridge									
Eastbound	5416-5417	24,164	27,249	25,512	23,219	26,339	39,812	22,742	25,902
Westbound	1824-1825	21,507	23,560	22,800	17,702	23,940	35,669	21,598	21,261
Total		45,671	50,809	48,312	40,921	50,279	75,481	44,340	47,163
Memorial Drive E of L. Anderson Bridge									
Eastbound	4414-4415	3,650	5,620	5,265	5,737	5,902	3,457	4,330	5,438
Westbound	4415-4414	6,863	9,283	7,636	8,925	8,909	4,628	7,976	7,433
Total		10,513	14,903	12,901	14,662	14,811	8,085	12,306	12,871
Mass Ave N of Waterhouse St									
Northbound	4387-4388	17,050	18,721	19,288	19,279	18,628	19,130	19,035	18,663
Southbound	4388-4387	16,131	17,990	18,409	18,543	17,921	18,435	17,140	18,523
Total		33,181	36,711	37,697	37,822	36,549	37,565	36,175	37,186

Table 5-A2. Summary of Peripheral Spot Location Volumes for All Scenarios.(1/2)

	Scenario	Base 1987	Base 2010	MED 3012	FULL 3013	LOW 3011	Policy 1 4012	Policy 2 5012	Policy 3 6012
Northwest									
Somerville Ave E of Porter Square									
Eastbound	4389-3519	10,916	12,445	11,784	11,997	12,408	12,030	11,656	12,103
Westbound	3519-4389	10,520	11,331	11,793	11,348	11,527	10,947	10,550	11,188
Total		21,436	23,776	23,577	23,345	23,935	22,977	22,206	23,291
McGrath Hwy @ Washington St Overpass									
Northbound	5258-5245	13,613	19,185	20,889	20,107	18,996	20,056	19,944	17,717
Southbound	5246-5259	14,487	16,211	17,149	17,292	16,483	16,444	11,514	16,558
Total		28,100	35,396	38,038	37,399	35,479	36,500	31,458	34,275
O'Brien Hwy. W of 2nd St									
Northbound	5264-3543	23,887	27,639	28,338	28,585	27,861	27,064	21,861	27,699
Southbound	3542-5265	17,449	24,658	25,478	25,408	23,876	24,652	25,151	22,331
Total		41,336	52,297	53,816	53,993	51,737	51,716	47,012	50,030
I-93 S of Sullivan Square									
Northbound	5174-5176	70,778	99,064	95,291	97,052	97,886	96,262	96,792	95,209
Southbound	5175-5173	62,634	104,754	105,749	105,162	106,124	105,690	94,320	105,122
Total		133,412	203,818	201,040	202,214	204,010	201,952	191,112	200,331
Sullivan Square Overpass									
Northbound	3459-3461	9,868	11,933	11,878	11,267	11,980	11,832	11,748	10,956
Southbound	3462-3460	10,274	14,606	14,063	13,632	14,746	13,880	12,064	14,608
Total		20,142	26,539	25,941	24,899	26,726	25,712	23,812	25,564
Northeast									
Tobin Bridge (Route 1 North)									
Northbound	1840-1841	56,619	68,906	67,426	67,219	68,382	67,111	63,595	65,792
Southbound	1652-1839	54,999	63,968	63,396	63,006	63,949	62,912	55,265	63,457
Total		111,618	132,874	130,822	130,225	132,331	130,023	118,860	129,249
Route 1A @ Boston Revere Line									
Northbound	3791-3787	27,814	33,966	33,629	34,066	34,083	34,799	34,337	33,953
Southbound	4756-3790	22,793	34,830	33,475	33,416	34,747	34,107	29,967	33,845
Total		50,607	68,796	67,104	67,482	68,830	68,906	64,304	67,798

Table 5-A2. Summary of Peripheral Spot Location Volumes for All Scenarios.(2/2)

	Scenario	Base 1987	Base 2010	MED 3012	FULL 3013	LOW 3011	Policy 1 4012	Policy 2 5012	Policy 3 6012
Screenline Counts									
Intermediate Ring									
Screenline South (Southampton St)									
William Day Blvd. S of Columbia Rd									
Northbound	4166-4168	3,386	3,309	3,184	3,328	3,174	3,469	3,502	3,134
Southbound	4168-4166	3,119	2,956	2,944	2,803	2,965	2,794	2,913	2,888
Total		6,505	6,265	6,128	6,131	6,139	6,263	6,415	6,022
Old Colony Ave N of Southampton St									
Northbound	4159-4160	13,570	22,005	16,531	19,783	17,782	23,390	17,666	20,990
Southbound	4160-4159	16,392	15,739	16,347	15,749	14,086	15,732	13,905	14,728
Total		29,962	37,744	32,878	35,532	31,868	39,122	31,571	35,718
Boston St N of Southampton St									
Northbound	3599-4143	3,352	3,359	3,317	3,631	3,196	3,003	3,318	3,066
Southbound	4143-3599	4,542	3,629	3,677	4,052	3,747	3,958	3,770	4,127
Total		7,894	6,988	6,994	7,683	6,943	6,961	7,088	7,193
Dorchester Ave N of Southampton St									
Northbound	3599-4139	4,340	4,283	4,194	5,098	3,816	5,137	3,943	3,847
Southbound	4139-3599	5,219	2,753	2,683	2,864	2,453	2,950	2,334	2,587
Total		9,559	7,036	6,877	7,962	6,269	8,087	6,277	6,434
Frontage Rd N of Southampton									
Northbound	3604-3606	7,220	8,653	9,685	8,359	9,127	10,074	7,067	8,810
Southbound		n/a	28,165	28,271	28,266	43,325	29,201	34,186	28,602
Total		7,220	36,818	37,956	36,625	52,452	39,275	41,253	37,412
Southeast Expressway @ Southampton St									
Northbound	2556-2557	102,802	118,283	122,904	121,646	122,184	115,189	119,013	117,551
Southbound	2544-2550	95,524	109,809	107,294	109,580	96,403	107,342	102,469	107,583
Total		198,326	228,092	230,198	231,226	218,587	222,531	221,482	225,134
Melnea Cass Blvd NE of Mass Ave									
Eastbound	2436-1660	34,937	27,564	28,460	29,776	28,025	26,342	28,508	28,659
Westbound	1663-2435	34,969	27,505	29,357	28,128	29,126	28,605	28,014	30,068
Total		69,906	55,069	57,817	57,904	57,151	54,947	56,522	58,727
TOTAL NORTHBOUND		169,607	187,456	188,275	191,621	187,304	186,604	183,017	186,057
TOTAL SOUTHBOUND		159,765	190,556	190,573	191,442	192,105	190,582	187,591	190,583

Table 5-A3. Summary of Intermediate Screen "Ring" Volumes for All Scenarios.(1/3)

	Scenario	Base 1987	Base 2010	MED 3012	FULL 3013	LOW 3011	Policy 1 4012	Policy 2 5012	Policy 3 6012
Screenline West (Mass Ave)									
Albany St E of Mass Ave									
Eastbound	2432-3133	5,513	5,465	6,588	5,623	5,182	5,032	5,556	5,508
Westbound	3133-2432	4,121	5,384	5,523	5,386	4,163	4,530	4,423	4,557
Total		9,634	10,849	12,111	11,009	9,345	9,562	9,979	10,065
Harrison Ave E of Mass Ave									
Eastbound	2431-2430	3,670	4,166	4,034	4,219	4,079	4,166	3,594	3,840
Westbound	2430-2431	5,385	6,414	6,414	6,559	6,181	6,322	5,824	5,423
Total		9,055	10,580	10,448	10,778	10,260	10,488	9,418	9,263
Washington St E of Mass Ave									
Eastbound	2429-3151	2,270	3,908	4,102	4,052	3,639	3,582	3,049	3,712
Westbound	3151-2429	1,659	2,317	2,550	2,742	2,246	2,125	2,154	2,554
Total		3,929	6,225	6,652	6,794	5,885	5,707	5,203	6,266
Shawmut St E of Mass Ave									
Westbound	2427-2428	1,705	1,128	1,215	1,328	1,080	854	1,148	1,136
Tremont St E of Mass Ave									
Eastbound	2426-2425	5,778	6,538	6,260	6,561	6,178	8,259	5,837	5,811
Westbound	2425-2426	5,903	8,457	9,590	9,781	8,332	6,978	7,842	9,530
Total		11,681	14,995	15,850	16,342	14,510	15,237	13,679	15,341
Columbus Ave E of Mass Ave									
Eastbound	2424-2370	7,320	8,551	8,760	8,263	8,258	9,206	7,719	7,715
Westbound	2370-2424	8,358	8,188	8,551	8,307	8,599	10,078	7,314	8,442
Total		15,678	16,739	17,311	16,570	16,857	19,284	15,033	16,157
Huntington St E of Mass Ave									
Eastbound	2423-2290	12,977	12,648	13,048	15,444	12,054	11,976	12,183	11,326
Westbound	2290-2423	15,219	15,353	18,974	18,544	17,061	17,559	18,289	17,598
Total		28,196	28,001	32,022	33,988	29,115	29,535	30,472	28,924
Belvedere St E of Mass Ave									
Westbound	2293-2421	1,651	2,330	1,727	1,141	2,467	1,469	1,823	2,362
Boylston St E of Mass Ave									
Eastbound	2420-2245	6,619	8,300	12,206	14,320	8,244	10,762	11,332	11,548
Westbound	2245-2420	2,636	2,537	n/a	n/a	n/a	n/a	n/a	n/a
Total		9,255	10,837	12,206	14,320	8,244	10,762	11,332	11,548
Newbury St E of Mass Ave									
Westbound	3234-3236	4,892	3,756	2,942	3,705	3,461	5,907	2,935	2,881
Comm Ave E of Mass Ave									
Eastbound Loc	3237-3109	548	950	1,627	1,564	771	1,475	1,193	1,951
Eastbound Thru	3421-3109	6,363	7,065	8,021	7,896	5,168	5,793	6,626	7,052
Westbound Loc	3108-3399	1,003	862	826	889	895	1,025	800	872
Westbound Thru	3108-3238	6,194	7,846	10,936	16,079	9,156	4,785	10,388	10,607
Total		14,108	16,723	21,410	26,428	15,990	13,078	19,007	20,482
Marlborough St E of Mass Ave									
Eastbound	3401-3400	1,068	903	857	881	790	876	801	946
Beacon St E of Mass Ave									
Westbound	3403-3402	3,959	5,599	8,861	11,249	3,584	6,275	7,069	9,157
Storrow Drive E of Mass Ave									
Eastbound	3404-2464	52,154	58,014	24,563	18,195	38,039	23,262	24,118	24,290
Westbound	2463-3065	55,017	60,664	32,606	20,929	62,129	30,780	30,591	34,065
Total		107,171	118,678	57,169	39,124	100,168	54,042	54,709	58,355
Turnpike E of Mass Ave									
Eastbound	5488-3425	64,667	80,277	84,130	85,663	81,025	101,643	75,864	83,435
Westbound	2408-2409	55,521	72,728	78,017	79,484	72,602	98,822	77,191	77,095
Total		120,188	153,005	162,147	165,147	153,627	200,465	153,055	160,530
TOTAL EASTBOUND		168,947	196,785	174,196	172,681	173,427	186,032	157,872	167,134
TOTAL WESTBOUND		173,223	203,563	188,732	186,123	201,956	197,509	177,791	186,279

Table 5-A3. Summary of Intermediate Screen "Ring" Volumes for All Scenarios.(2/3)

	Scenario	Base 1987	Base 2010	MED 3012	FULL 3013	LOW 3011	Policy 1 4012	Policy 2 5012	Policy 3 6012
Screenline North									
Longfellow Bridge									
Northbound	2160-2161	15,863	16,671	21,020	21,724	17,617	20,235	20,667	20,595
Southbound	2162-2163	14,623	16,963	23,431	24,774	18,671	23,252	20,603	20,865
Total		30,486	33,634	44,451	46,498	36,288	43,487	41,270	41,460
Charles River Dam									
Northbound	2135-2136	21,410	27,674	26,495	27,304	27,365	25,405	24,064	26,286
Southbound	2137-2138	30,387	32,430	30,556	31,584	31,580	30,294	25,266	28,916
Total		51,797	60,104	57,051	58,888	58,945	55,699	49,330	55,202
Artery Bridge									
Northbound	2113-1834	88,823	133,561	136,595	138,048	132,807	133,658	131,521	134,366
Southbound	1833-2116	90,342	140,087	140,038	140,849	138,353	138,202	127,978	140,245
Total		179,165	273,648	276,633	278,897	271,160	271,860	259,499	274,611
"Leverett Bridge"									
Northbound	6251-6447	n/a	73,685	58,918	58,601	70,891	56,847	57,560	58,057
Southbound	6444-6445	n/a	74,846	71,170	67,565	74,583	65,801	61,742	68,112
Total		n/a	148,531	130,088	126,166	145,474	122,648	119,302	126,169
Charlestown Bridge									
Northbound	3395-3396	32,308	32,282	33,206	33,521	31,779	32,375	30,535	33,559
Southbound	3397-3398	31,464	26,713	25,956	25,927	26,531	24,527	16,775	25,587
Total		63,772	58,995	59,162	59,448	58,310	56,902	47,310	59,146
TOTAL NORTHBOUND		158,404	283,873	276,234	279,198	280,459	268,520	264,347	272,863
TOTAL SOUTHBOUND		166,816	291,039	291,151	290,699	289,718	282,076	252,364	283,725
Screenline East									
Callahan Tunnel									
Eastbound	5499-5496	55,928	43,043	41,093	40,912	42,557	40,035	32,013	40,234
Sumner Tunnel									
Westbound	5497-5498	52,691	44,819	43,658	43,484	44,697	42,354	37,290	44,016
Total		108,619	87,862	84,751	84,396	87,254	82,389	69,303	84,250
Third Harbor Tunnel									
Eastbound	6398-6399	n/a	52,090	55,457	56,155	52,012	56,555	45,729	54,060
Westbound	6413-6415	n/a	50,217	51,821	52,475	50,100	53,694	44,064	51,671
Total			102,307	107,278	52,475	50,100	53,694	44,064	51,671
TOTAL EASTBOUND		55,928	95,133	96,550	97,067	94,569	96,590	77,742	94,294
TOTAL WESTBOUND		52,691	95,036	95,479	95,959	94,797	96,048	81,354	95,687
Intermediate Ring Screenline Summary									
TOTAL TRIPS IN		505,370	675,280	653,622	655,001	650,449	654,712	593,253	636,916
TOTAL TRIPS OUT		491,392	677,992	655,539	656,763	674,520	656,611	629,729	649,725

Table 5-A3. Summary of Intermediate Screen "Ring" Volumes for All Scenarios.(3/3)

station	zone	trips	zone	trips	zone	trips	zone	trips	trips	adj	conversior factor
JFK	91	1017	131	3858	132	824	135	1421	7120	3560	0.5
Everett	136	1410	137	1410					2820	2820	1
Newmarket	99	1500							1500	1500	1
Melnea Cass1	59	3220							3220	3220	1
Melnea Cass2	102	1500	103	1410					2910	2910	1
Ruggles	97	5000	98	7000	104	4570	105	1500	18070	9035	0.5
Huntington	97	6190	106	1500	107	1500			9190	4595	0.5
Longwood	97	2780	108	10000					12780	6390	0.5
Park Dr	96	6220	232	3000					9220	4610	0.5
BU	95	10000	96	1460	232	3000			14460	7230	0.5
MIT	197	10940							10940	5470	0.5
Kendall	189	3130	190	6000	197	5000			14130	7065	0.5
Third	187	1360	189	1000					2360	2360	1
Lechmere	187	3130							3130	1565	0.5
Comm College	73	1000	75	2000	76	3628	77	2492	9120	4560	0.5
									120970	66890	
									77000		
									43970		
									0.6365		

adjusted (linked vs. unlinked trip increase)

station	zone	trips	zone	trips	zone	trips	zone	trips	trips	adj
JFK	91	508	131	1929	132	412	135	711	3560	3560
Everett	136	1410	137	1410					2820	2820
Newmarket	99	1500							1500	1500
Melnea Cass1	59	3220							3220	3220
Melnea Cass2	102	1500	103	1410					2910	2910
Ruggles	97	2500	98	3500	104	2285	105	750	9035	9035
Huntington	97	3095	106	750	107	750			4595	4595
Longwood	97	1390	108	5000					6390	6390
Park Dr	96	3110	232	1500					4610	4610
BU	95	5000	96	730	232	1500			7230	7230
MIT	197	5470							5470	5470
Kendall	189	1565	190	3000	197	2500			7065	7065
Third	187	1360	189	1000					2360	2360
Lechmere	187	1565							1565	1565
Comm College	73	500	75	1000	76	1814	77	1246	4560	4560
									66890	66890

Table 5-A5. Calculation of Zonal Trip Reduction Based on Station Boardings.(1/2)

zone	red trips	occ factor	cur trips	perc reduc	remain trips
59	3220	2683	7557	43%	4873.7
73	500	416.7	5257	10%	4840.3
75	1000	833.3	4286	23%	3452.7
76	1814	1512	3628	50%	2116.3
77	1246	1038	2547	49%	1508.7
91	508	423.3	1017	50%	593.67
95	5000	4167	17591	28%	13424
96	3840	3200	12892	30%	9692
97	6985	5821	20147	35%	14326
98	3500	2917	21810	16%	18893
99	1500	1250	11203	13%	9953
102	1500	1250	4229	35%	2979
103	1410	1175	3261	43%	2086
104	2285	1904	8694	26%	6789.8
105	750	625	2916	26%	2291
106	750	625	2083	36%	1458
107	750	625	3142	24%	2517
108	5000	4167	40082	12%	35915
131	1929	1608	7275	27%	5667.5
132	412	343.3	824	50%	480.67
135	711	592.5	4738	15%	4145.5
136	1410	1175	3836	37%	2661
137	1410	1175	2570	55%	1395
187	2925	2438	22462	13%	20025
189	2565	2138	11389	23%	9251.5
190	3000	2500	14592	21%	12092
197	7970	6642	33979	23%	27337
232	3000	2500	8670	35%	6170
	66890	55742	282677	24%	226935

Table 5-A5. Calculation of Zonal Trip Reduction Based on Station Boardings.(2/2)